MAY 16, 1921 Issued Weekly PRICE 15 CENTS

# AVIATION AND AIRCRAFT JOURNAL

President Harding Aboard the Mayflower Steaming out into Hampton Roads to Review the Fleet

VOLUME X
Number 20

Four Dollars a Year

## SPECIAL FEATURES

POSSIBILITY OF REACTIVE PROPULSION IN AIR
PLYWOOD IN AIRPLANE CONSTRUCTION
THE BACO "SKYLARK"
THE BRITISH PASSENGER AIRSHIP G-FAAF
FRENCH STATE AERODROMES FOR CIVIL USE

THE GARDNER, MOFFAT CO., INC.
HIGHLAND, N. Y.
225 FOURTH AVENUE, NEW YORK



Entered as Second-Class Matter, Nov. 22, 1920, at the Post Office at Highland, N. Y.

MAY 16, 1921

# AVIATION AND AIRCRAFT JOURNAL

VOL. X. NO. 20

*Member of the Audit Bureau of Circulations*

## INDEX TO CONTENTS



THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*

HIGHLAND, N. Y.

225 FOURTH AVENUE, NEW YORK

SUBSCRIPTION PRICE: FOUR DOLLARS PER YEAR. SINGLE COPIES FIFTEEN CENTS. CANADA FIVE DOLLARS. FOREIGN SIX DOLLARS A YEAR. 

ISSUED EVERY MONDAY. FORMS CLOSE TEN DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER NOV. 22, 1920, AT THE POST OFFICE AT HIGHLAND, N. Y., UNDER ACT OF MARCH 3, 1897

L. D. GARDNER, PRESIDENT
W. D. MOFFAT, VICE-PRESIDENT
W. I. SEAMAN, TREASURER
GEORGE NEWBOLD, BUSINESS MANAGER

# AVIATION AND AIRCRAFT JOURNAL

LADISLAS D'ORCY, EDITOR
ALEXANDER KLEMIN, TECHNICAL EDITOR
EDWARD P. WARNER, CONTRIBUTING M. I. T. A. EDITOR
RALPH H. UPSON, CONTRIBUTING L. T. A. EDITOR

Vol. X MAY 16, 1921 No. 21

## Congratulations

GENERAL MENOHER and General Mitchell are receiving well deserved congratulations on their promotions. General Menoher has been promoted to the permanent rank of Major General and General Mitchell "to be assistant to the Chief of the Air Service for a period of four years with rank as brigadier general from July 2, 1920."

The Chief of the Air Service is a position that is increasing in importance more rapidly than any other army detail. Aviation is coming into its own as the third branch of national defense and while it will take time to reach the independence it deserves, it will, nevertheless, grow in importance each year. General Menoher took the Air Service when it was in a difficult period and during the contraction after the armistice has shown qualities which have brought to him not only respect but great admiration. It was a time when good judgment and clear thinking were needed and in these qualities, General Menoher has proved himself a sound leader. While those who have been interested in the fullest development of aviation have been proposing every sort of utilization of aircraft, General Menoher has listened patiently and after the fullest consideration he gave his decisions with a clear understanding and justified conservatism. He has literally tried to "keep his feet on the ground." To him, AVIATION AND AIRCRAFT JOURNAL extends its congratulations and every good wish.

General Mitchell whose name will always be famous as the pioneer in governmental aviation has, by his brilliant leadership and fearless testimony given aviation in this country an impetus that no other less gifted officer could. To see General Mitchell, who by all the standards is beyond the "flying age," take almost any airplane on a field, fly it well, "stunt" it and lead any maneuver, is enough to thrill the citizen who looks on the Air Service as only for youngsters.

The future will justify General Mitchell's vigorous prophesies. None of the most fanciful pictures of the use of airplanes in warfare were nearly as heroic or inspiring as the realities. May General Mitchell be the prophet, unfettered by the blighting hand of officialdom, to point the way to the broader employment of aviation as the surest way to peace and progress.

## The Prediction of Stability

STABILITY has suffered much by being misunderstood, and many pilots declare themselves opposed to stable airplanes without fully understanding in what stability consists or what it means to the operator of the aircraft. Stability does not necessarily entail heaviness of control even in the slightest degree, and a stable airplane can be quite as maneuverable as and much more pleasant to fly than one of unstable characteristics.

The question of stability is enshrouded in some mystery because it is unfortunately inseparable from a rather involved mathematical theory, but the results of the application of that theory are eminently practical. What is most needed at the present time to enable the designer better to predict the stability and control of a new airplane or to make any desired changes in those characteristics is further data on the performance of existing airplanes. It is very important for the advancement of the art that such work as has been done in the last two years by the National Advisory Committee at Langley Field and by other agencies in this country and abroad should be continued and extended as much as possible. If complete stability data were available for 50 or 100 different types of airplanes we would be in a far better position to draw empirical rules and make practical applications than we are now when our information is restricted to a bare half dozen designs.

## The Place of the Amphibian

AFTER the first crude attempts of a few years ago the building of amphibious aircraft fell into disfavor and the public attitude was summarized by Louis Paulham's sneering remark "The only duck with wheels is a tin one". Today, however, it is universally realized that the amphibian has a distinct sphere, at least in naval operations.

Even more important than this, however, are its possibilities of use in commercial transport, as the amphibian makes it possible to fly directly from city to city, passing over land and water indiscriminately and without danger and to land at the waterfront, which in most cases abuts directly upon the business district, instead of having to make the terminus at a field from 5 to 20 miles out of the city. It is presumably with this great prospective advantage in mind that the British Air Ministry have devoted so much attention during the past year to the development of the amphibian, for which type of aircraft a special class was provided in the British Commercial Competition of last summer. Although there are several very satisfactory amphibious gears at the present time the question of amphibian design is one which will repay much further serious study on the part of engineers.

## French State Air Ports

IN the present issue there is printed the organization scheme of the various classes of air ports which the French government provides for commercial and civil uses. It will be seen that the system is based on the possibility of the smallest ground organization expanding into the most complete establishment. This seems to us an important provision. To lay out a small air port on a site where its future expansion is impossible is poor policy. To embody the principle of natural expansion in the organization scheme of airports shows forward looking policy.

# Possibility of Reactive Propulsion in Air

By B. T. Koleroff, M. E.

Any installation of a reactive propulsion set will consist necessarily of three essentially different parts. First, of a device for feeding the active fluid into a pressure chamber, second, of an arrangement for the combustion of this active mass, and finally, of the reactive apparatus proper. That which determines the practical value of the reactive installation is, of course, the reactive apparatus itself. The purpose of this article is to set forth briefly the underlying principles of such a device, and to consider its possibility.

At the time when the first thought of a flying machine heavier than air originated, we also find the idea of a simple jet propulsion attracting the attention of inventors by its simplicity. The utilization of simple jet reaction for propulsion purposes proved to be very uneconomical on account of excessive gas consumption and a small mechanics effect at the same time. After these unsuccessful attempts, reactive propulsion was for a long time forgotten. Then in 1909 C. J. Lake took out a patent in France in which he proposed to entrain the outside air by means of jets of combustible fluid discharged from nozzles under pressure. At the Aero Show in Paris in December, 1919, H. F. Melot demonstrated his "Propulseur Trompe", with which he conducted some successful experiments. He created a powerful air stream by means of discharged gas jets entraining the outside air through a number of conical surfaces. Mr. Melot, as well as Mr. Lake, considered the expansion of the gases in the cones as the factor producing the entrainment of air and therefore the action of the apparatus. In the present article the writer presents his principle of momentum increase of an active jet by means of proper entrainment of the outside air due to a vacuum created in the apparatus. On this theory he bases the essential feature of his reactive apparatus, patent for which has been granted. The reactive force necessary for propulsion is equal to the momentum $m\,w$ of the jet discharge in unit time, and therefore is determined by the mass of the gas $m$, ejected per second and the velocity $w$ of ejection.

The velocity $w$, determined by a fall of temperature or pressure, can be increased only to a certain value, which may, however, be very high. The velocity $V$ of the vessel is insignificant at low altitudes due to the considerable atmospheric resistance. Therefore the ratio of $w/V$ is very large and the efficiency of propulsion $\eta_m$, which is practically inversely proportional to that ratio, is very low. At high altitudes, where with the same power $V$ would greatly increase, this efficiency would improve. Because of added weight the increase of the quantity $m$ of the ejected mass of gas is impractical.

This explains why numerous attempts to utilize simple jet propulsion have resulted in failures. The insignificant force effect of simple jet action, coupled with low efficiency, makes the utilization of that method uneconomical at low altitudes.

There remains, however, a modification of the method of propulsion and that is by means of the utilization of the reactive force of the ejected gas together with the stirring up of the enveloping medium. It would seem possible to obtain an increase of reactive force $F$ by a proper entrainment of the encircling air by means of streams of active gas, which would increase the total momentum of the gas mixture. In that case, the efficiency of energy expenditure should increase, because both factors, determining the useful work per second $F\,V$, would increase without an increase of energy spent. The neglect to consider the above modification of the method of reactive propulsion is explained by the generally adopted view of the impossibility of increasing the momentum of the jet. This opinion is based on the fact that the medium into which the gas is ejected is initially at rest and so that when the active jet entrains a given mass of the medium, having no initial velocity, the total momentum cannot increase, according to the law of conservation of momentum.

In the author's opinion this view is erroneous. The ejected gas, due to the viscosity of gases, entrains the external air creating a vacuum around the jet. Due to the latter, the particles of the enveloping air rush toward the jet with some velocities. Even in the case of a free jet those initial velocities, due to the paraboloidal outline of the jet, have a certain slope toward the axis of the latter. By the law of conservation of momentum, the total momentum of the mixture must increase due to the presence of axial components of the momenta of the approaching air. That such an increase takes place can be proved by the fact that the jet impact exceeds its reaction, which was found to be true by Capt. Th. Morley in his experiments at Glasgow University.

The kinetic energy which the outside air receives due to the vacuum about the jet is obtained from the heat of the air itself. The process takes place according to the law of adiabatic expansion and is followed by a corresponding drop in temperature. By the use of proper surfaces to guide the air drawn in by the active jets in the direction of their axes, the vacuum around the latter is increased and these both increase the axial component of the momentum of the air taken in. After the entrainment of a certain portion of the air, when the pressure gradually rises again to the prevailing pressure of the medium, the gas mixture loses a part of its kinetic energy equal in amount to that which has been imparted to the air before the actual entrainment of the latter. That energy is again converted into heat. Thus an artificial drop of pressure is created in the medium.

If the air enters the apparatus through separate and consecutively placed channels, the velocity of the air in the first channel increases. Accordingly, the velocity of the active mixture in that channel will also increase, thus raising the velocity of the air entering the second channel, and so on. The total increase of the air velocity affected by such consecutive arrangement of channels will increase the efficiency of energy transfer $\eta_a$. The reactive force developed by the apparatus will consequently also increase.

By having the jet nozzles also arranged consecutively along the apparatus, we spread the suctional action of the active jets upon the whole device. The entrained air reduces the energy of the active mixture, while the new streams of active gas continuously contribute to its increase. The process thus consists of a *gradual* transfer of kinetic energy to the air, which decreases the sliding friction of the particles and consequently also the loss of energy in the transfer. That again raises the efficiency $\eta_a$. Thus the admission of air in successive steps and the successive action of the jets become the most important features of the apparatus under consideration. The velocity of the admitted air, and, consequently, the efficiency of the device, are determined by constructional features which insure the maintenance of the proper vacuum within the apparatus during the increase of the mass of air taken in. The important conditions which determine the vacuum and, consequently, also the efficiency of the apparatus are as follows:

1. The plural use of parallel nozzles, discharging jets of active gas.
2. The admission of air in the direction of active jets by means of guiding surfaces which constitute at the same time mixing chambers.
3. The distribution of those surfaces consecutively along the axis of the jet.
4. The use of several groups of nozzles arranged successively and longitudinally with the apparatus.
5. The use of the diffuser for final discharge of the mixture from the apparatus into the atmosphere.

In order to reduce the air resistance encountered by the apparatus in its motion and to obtain a more efficient distribution of the useful pressure on the guiding surfaces, the latter should have a curved profile, similar to the wings of an airplane.

During the motion of the apparatus the velocity of the air drawn in is increased by its relative velocity toward the apparatus. This results in a higher total velocity of the entraining air, the ratio of interacting velocities changes toward the unity and the efficiency $\eta_a$ increases. With the increase of the velocity of the vessel $V$, the additional velocity $w$ imparted to the air falls in spite of the increase of the efficiency of energy transfer $\eta_a$ because

1. The mass $M$ of the entrained air increases due to the motion.

2. The energy loss in the medium $\frac{M w^2}{2}$ falls through the rise of the energy spent on the motion $F V'$, although the actuating force decreases. Consequently, with the increase of the velocity of motion, the ratio $\frac{w}{V}$ falls and the efficiency of motion $\eta_m$ rises. The total efficiency of reactive propulsion in air $\eta = \eta_\rho\ \eta_a\ \eta_m$ also rises with the motion, because the partial efficiencies depending upon the motion $\eta_a$ and $\eta_m$ both rise, while $\eta_\rho$, the efficiency of gas ejection practically remains the same. This particular feature of the apparatus under consideration makes for a wider range of possible velocities and thus presents an important advantage over a propeller.

Comparing the driving force of the propeller for the USD-9A at its maximum velocity, with the reactive force developed by simple jets, the total gasoline consumption in both cases being the same, we obtain an approximate ratio of 8.5 to 1. Now, then, if the projected apparatus can give an increase of reactive force of 8½ times under the same conditions of speed, fuel consumption, etc., the resulting motion will be, naturally the same in both cases.

The constructional advantages of the apparatus, due to its light weight and elimination of noise and moving parts, together with the increase of efficiency with the increase of velocity are obvious.

It is clear that under such conditions, rising to high altitudes will cease to be a sport—"jumping into a vacuum"—but will become an actual scientific problem which awaits its practical solution, because in this case, even in the absolute vacuum there remains a moving force i.e., the reaction of simple jets and the self-support of the weight of the apparatus by the centrifugal force, due to the high velocity which may be developed at high altitudes in the rarified atmosphere.

## Trade Note

### Plymetl—A New Engineering Material

The Haskelite Manufacturing Corp. of Chicago, have made an interesting announcement of a new material called Plymetl, which may have decided possibilities in aircraft construction.

Plymetl is manufactured by cementing thin sheet metal faces to a relatively thick core of light weight material. This sheet metal forms a smooth, impervious, and durable surface. The non-metal core spaces the faces relatively far apart making the material strong and stiff in bending, and still light in weight. Thus Plymetl bears practically the same relation to sheet metal that the steel I-beam with the thin web does to a solid bar of steel of rectangular section. The steel I-beam is relatively light, strong, and stiff, in the same way and for the same reason, Plymetl is relatively light, strong and stiff.

It is furnished from stock in panels 5/16 in. thick with faces of black or galvanized sheet metal, No. 30 gauge, and with planed wood veneer cores. Weight about 1.8 lb. per sq. ft. Sizes of panels 30 x 96 in. The material is manufactured to order with other sheet metals, and with cores of other thicknesses to suit special requirements, and can be cut with both circular and band saws.

RESULTS OF ENGINEERING TESTS

*Thickness over all*: 5/16 in.
*Faces*: Black sheet steel No. 30 gauge.
*Core*: Fir wood veneer, planed.
*Weight*: 1.8 lb. per sq. ft. practically the same as sheet steel of No. 16 gauge.
*Stiffness*: Five times as stiff as 5/16 in. solid wood panel; or eighty times as stiff as sheet steel of same weight, No. 19 gauge.
*Elastic limit in bending*: 75 in.-lb. per inch width, or about five times the elastic limit of sheet steel, No. 19 gauge.
*Impact test*. A panel 12 in. x 12 in. was placed on a steel frame having a clear opening, 10.5 in. x 10.5 in., and a steel hammer weighing 12.5 lb. was dropped 20 in. on the middle of the panel, producing a permanent deflection of about 0.09 in., but not injuring it otherwise. Same test on a panel of sheet steel of No. 20 gauge produced permanent deflection of about ⅜ in., buckling the sheet badly out of shape.
*Shearing strength of joints*: Bending a short end causes the wood core to fail in shear in the wood, showing that the shearing strength of the cement that binds the metal to the core is even greater than the shearing strength of the wood.
*Fatigue test*. Strip 24 in. long was supported at ends and middle oscillated ½ in. in opposite directions, fiber stress in steel about 24,000 lb. per sq. in. At 4,200,000 oscillations the steel faces were broken about 2 in. from middle. No separation of plies occurred. Similar test on 5/16 in. strip with cork core showed similar result at about 5,400,000 oscillations.

A standard Brindell machine for determining hardness of metals is listed. This is a complete machine with automatic weight control to insure correct test loads independently of the accuracy of the pressure gage, with 3000 kg. maximum test pressure, with twelve special balls of 10 mm. diameter.

A very interesting machine is a complete universal wearing testing machine for metals and alloys—applicable particularly to materials used in engine construction—for tests on rolling or sliding surfaces, dry or lubricated, under variable speeds and pressures. In selecting suitable alloys and determining their most effective heat treatment to resist abrasion or "wear". It has often been assumed that the harder the material, as examined by the customary hardness tests, the greater should be its resistance to such forces. However, it has recently been definitely established that there is no relation between the property we call "hardness" of metal and its wear-resisting qualities. In this machine the tests are made by using disc specimens, which rotate in pure rolling or sliding action against each other's edge. The wearing effect on the specimens is produced by simultaneous rotation alone, or by rotation combined with friction, or by friction only. The machine is fully equipped with the necessary dynamometric devices to measure the force developed and work performed during a test. The testing conditions can be varied within wide limits.

The makers also list other interesting machines for material testing, such as the Humfrey static notched-bar testing machine for the quantitative measurement of the brittleness and ductibility of steel and other metals.

For fatigue investigations the Eden-Foster repeated impact testing machine is listed. In the design of a machine for testing by repeated impact several considerations must be taken into account if the results of tests are to be interpreted accurately. It is essential that the true energy of the blows should be calculable if various results are to be truly comparable. In some designs hitherto used these conditions have not been strictly fulfilled, the hammer had attachments and some doubt always existed as to how much of the mass of the attachments was actually effective in the blow. Lack of rigidity was another embarassment because the result depended largely on the nature of the base upon which the machine was mounted. In the design of the Eden-Foster repeated impact machine these requirements have been fully met. The hammer is without attachments and falls freely under the influence of gravity, the whole falling mass of the hammer is symmetrically disposed above the point of impact and the actual height of the fall may be measured easily so that the true energy of the blow is calculable to a high degree of accuracy.

A very useful 50 ton tensile machine of the Amsler type does all the work necessary for compression, transverse and bending tests.

Photo-micrographic cameras are listed, which are of use in a study of steel and aluminum alloys.

The Mojoiner moisture testers look like very handy instruments for testing the moisture of spruce and other timber

# The BaCo Skylark

The BaCo Skylark, an all purpose plane, was designed by the Bethlehem Aircraft Corp to fulfill a variety of uses It is a two seater side by side airplane, with dual control, making it ideal for passenger carrying or instruction work.

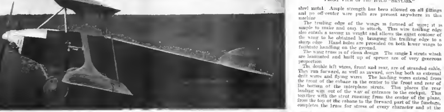
The passenger acquires greater self-confidence and pleasure when sitting alongside of the pilot in seeing the ease with which the machine is controlled. The ability to converse freely without the aid of a speaking tube or the sign language is a valuable asset The ease with which the Skylark can be handled, or stored, on the ground and its low operating expense, makes it a very desirable machine for the gentleman or lady who employs a pilot, or for the instructor or the owner-pilot. It is ideal for cross-country flying because of its quick take-off, long flight duration and slow landing speed.

The corporation's first airplane was designed by their Engineer and Vice President, Garrett B Linderman, 3rd, E. M. and tested out by Bruce Eytinge, their Sales Manager, during October, 1920, when eighteen test flights were made proving that the actual performance of this two-seater machine, with only a 60 hp. Lawrance engine, is superior to that of many a machine with much greater horsepower This is chiefly due to the fact that the entire airplane is very efficient and light, although it has a high safety factor of 9.

The new model, as herein described and illustrated, was given its initial test flight May 2, 1921. The pilot's statement is as follows

"At 7 45 P M I opened the throttle and took off up a long steep grade into a light west wind, not even a test hop, I simply took off and cleared the telegraph wires by 400 ft. which were 1800 ft from my starting point. The engine ran perfectly at 1800 rpm.

I circled around, climbing to 3000 ft, over Bethlehem, and after feeling out the machine in turns and observing all instruments, I throttled down, approaching the field by S turning and in a slow flat glide, clearing the high tension power wires by a few feet, and, as my observers said, made a perfect three point landing at 7 55 It is the most practical airplane I have ever flown or tested"



SIDE VIEW OF THE BACO "SKYLARK", A TWO-SEATER SPORT AND TRAINING AIRPLANE FITTED WITH THE 60 HP. LAWRANCE RADIAL 3-CYLINDER ENGINE

The machine rolls but a short distance after the wheels touch the ground due to its lightness and the large angle of the wings.

The great inherent stability of this machine and slow landing speed make it one of the safest machines produced to date. When the control stick is released the machine will settle by itself to its natural flying angle, which may be varied by the adjustable stabilizer It will do this from either of the two extreme positions of a stall or vertical nose dive It is also laterally stable, so that it may almost indefinitely be flown with "hands off" the stick.

A model was tested by the Bureau of Standards to prove the theory of this design and construction, yet it does not differ from standard and accepted practice. The adjustable stabilizer assures a balanced machine in flight regardless of load, eliminating excess strain on the pilot All surfaces are large and answer to the slightest touch, but are not over sensitive, assuring maximum control at minimum flying and landing speeds.

The machine is easily entered by means of a low step on to the wing and another low step into the cockpit through the side door entrance in the body. The control stick and rudder bars are of the standard type. The roomy upholstered cockpit with attractive instrument board, presents a pleasing and comfortable compartment for the pilot and passenger To carry a few hundred pounds of mail, express or baggage, instead of a passenger, the extra seat is pushed back, or removed, and the control stick is removed also, giving ample cargo space.

### General Description

*Main Planes* Four-aileron type, of even span Wing section U S A 27, set at an angle of 1 deg incidence on the upper wing and 0 deg incidence on the bottom wing, and at 1½ deg. dihedral No sweep-back.

Wings are in four units Top wings are joined together and supported in the center by two inverted V streamline steel struts, giving the best possible vision to a side by side seater, easy access to the cockpit and eliminating the center section. They are held in position at the center, longitudinally, by a streamline steel strut. Internal lateral control mechanisms are accessible for inspection through aluminum covered openings in the wings

Front spars are of selected spruce, 4-ply laminated rectangular sections Rear spars are of I beams sections of spruce. They are built up so as to form a section similar to the ordinary routed spar It consists of two spruce members of shallow U shape, with the bottoms of the U side by side, and





with a center piece of 1/16 in. veneer, the grain running vertically to take the longitudinal sheer.

Cap strips of the spars are of birch ⅛ in. thick. Their construction is very logical since the veneer takes the horizontal shear across the grain, and the cap strips of birch utilize a material of high strength where the fibre stress is greatest

The internal bracing system is of double swaged wires and forked ends attached to mild steel fittings bolted to the main spars which are left solid at these points Main plane fittings are of standard and simple design made up of plain mild steel

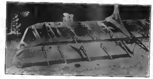
FRONT VIEW OF THE BACO "SKYLARK"

sheet metal Ample strength has been allowed on all fittings and no off-center wire pulls are present anywhere in this machine

The trailing edge of the wings is formed of wire; it is simple to make and easy to attach. This wire trailing edge also entails a saving in weight and allows the exact contour of the wing to be obtained by bringing the trailing edge to a sharp edge Hand holes are provided on both lower wings to facilitate handling on the ground.

The wing truss is of clean design The single I struts which are laminated and built up of spruce are of very generous proportion

The double lift wires, front and rear, are of stranded cable. They run forward, as well as inward, serving both as external drift wires and flying wires The landing wires extend from the front of the cabane in the center to the front and rear of the bottom of the interplane struts. This places the rear landing wire out of the way of entrance to the cockpit. This together with the strut running from the center of the plane, from the top of the cabane to the forward part of the fuselage, completes the truss for stress of every character and at the same time reduces the parasite resistance to a minimum; nevertheless the use of the deeply cambered U S A.27 wing section enables the weight of the wing truss to be kept down to a minimum



PORTION OF A WING, UNCOVERED, OF THE BACO "SKYLARK"

Wing frames are covered with approved grade A cotton fabric and special care has been exercised in sewing the fabric to the ribs in accordance with Army specifications. Surface treatment is of six coats of Phenix fireproof dope with a bronze finish

*Fuselage* The body is solidly constructed A complete trussing is provided of four solid spruce longerons with diagonal bracing members also of spruce The whole is covered with mahogany, 3-ply veneer Although very light, the fuselage has a strength far in excess of that required either in the air or on landing Great care has been exercised not to weaken the fuselage at the point where the door to the cockpit is placed. Special diagonal and longitudinal members being provided at that point to carry the truss through

The smooth mahogany finish is particularly pleasing to the eye and touch. A veneer fuselage of this type eliminates all fittings and provides a good production job easy of repair. The combination of veneer with the complete wooden truss also eliminates all tendency for warping or distortion of veneer

*Empennage.* The empennage is substantially built, as shown in the accompanying illustration. The stabilizer is hinged on the rear end so that a large degree of adjustment is possible in flight Since the balance of the machine is perfect for normal performance, it is expected that the stabilizer adjustment will only be used when the pilot wishes to fly at one particular flight attitude for a long period of time.

The stabilizer as shown in the photograph, has a strong rear spar running continuously over-top of the fuselage The laminated front edge is in one piece of semi-circular shape, three ribs on either side give it adequate strength and preserve the camber required. A strong spruce member runs on either side of the fuselage from the forward point of attachment of the stabilizer toward the outer end of the rear spar Two

EMPENNAGE OF THE BACO "SKYLARK" BEFORE BEING SURFACED

wires run from the top of the rudder post to the outer end of the stabilizer spar giving added security for severe maneuvers. The stabilizer and rudder are of similar construction and are well braced internally. The elevator horns are skillfully disposed within the vertical fin and a particularly strong torsion tube is provided to carry the elevator loads to the elevator horns The design of the empennage is particularly sturdy and clean and combined with simplicity

*Chassis* The chassis is of ⅝ in. by 1½ in. oval steel tubing brazed to a guide plate, which allows a 4 in. travel of the axle The shock absorber cord is simply wound about two spools, provided on the axle, and down under the guide plates. The cross wiring for the chassis struts is provided on both the front and rear struts. Two compression tubes run between the lower end of the front and rear struts. The chassis is very simple in construction and can be dismounted and assembled in a few minutes.

*Cockpit* In the cockpit ample room is provided for two persons side by side together with dual control. The instruments are symetrically arranged on a dash board clearly seen by either occupant. The engine controls, namely, switch, altitude adjustment and spark are placed on the right hand side The throttle is placed between the occupants and easily accessible to both The instrument board carries a banking indicator, turn indicator, air speed meter, altimeter, tachometer, oil pressure gauge, oil temperature gauge and air distance recorder A compass completes the equipment.

The arrangement of the cockpit and instruments is such as to make a perfect dual control arrangement, but with more facility for engine control, thus giving to the pilot a valuable point in instruction flying Access to the cockpit is particularly easy from the running board.

*Power Plant.* The power-plant, a Lawrance, 3-cylinder, radial, air-cooled engine of 60 hp. efficiently blends into the finely streamlined body, only exposing the cylinders for cooling purposes.

This engine has gone through the standard 50 hour Army test. It is supported by two steel plates, one on either side. These plates are bolted to the vertical veneer nose panel, which in turn is braced by two veneer tie-panels to the longerons. This eliminates all cross bracing wires in the first two sections, giving a very strong mounting.

Two complete double ignition systems are provided with double batteries so that either battery can be used on either system. Ample space is provided around the dual ignition systems and oil leads to the engine. A fire wall separates the engine and ignition system from the gasoline tank and cockpit. Thus fire risk is absolutely eliminated because the carburetor hangs outside and underneath the engine, doing away

BRIG. GEN. WM. MITCHELL TELLS COMDR. KENNETH WHITING HOW THE ARMY AIR SERVICE IS GOING TO SINK THE BATTLESHIPS IN THE TRIALS NEXT SUMMER

with the collecting of any overflow gasoline. If a backfire occurs, the live flame would be dissipated in the open air by the propeller blast.

A 20-gal gravity tank provides fuel for over four hours at a cruising speed of 70 miles per hour.

SPECIFICATION OF THE BACO SKYLARK

Span, both planes 26 ft. 10 in
Chord both planes, 45 in
Clear gap between planes 46 in
Stagger 30 in
Length, overall, 23 ft
Height, overall 8 ft
Wing curve, U. S. A. 27
Total wing area, 214 sq. ft
Dihedral, both wings, 1½ deg
Weight empty, 790 lb
Useful load 600 lb
Loading per sq. ft., 8 lb
Loading per horsepower 19.8 lb
Maximum speed, 90 m.p.h.
Minimum speed 33 m.p.h.
Flight duration, 4½ hr
Climb, full load 600 ft. per min
Ceiling 18,000 ft
Gasoline tank capacity, 20 gal
Oil tank capacity, 2 gal.

DESCRIPTION OF 60 HP LAWRANCE ENGINE

Type, 3 cylinder radial type
Horsepower, rated 60 hp. at 1800 r.p.m.
Weight, complete 140 lb
Bore, 4.25 in
Stroke 5.25 in
Cylinders cast aluminum with steel liners
Crankcase, cast aluminum with cover plate.
Crankshaft, drop forged, chrome vanadium steel.
Connecting rods, same as crankshaft.
Pistons, magnalite, 2 rings and one whipper ring
Valves, inlet tungsten steel, 2-1/16 in diameter
Valves, exhaust, tungsten mercury treated
Ignition, dual verticals, [illegible] magnetos
Carburetor, duplex Stromberg
Gasoline consumption, 5 gal per hour
Gasoline feed, gravity
Lubrication, full pressure feed, dry sump.
Oil consumption, one pint per hour
Cooling, by air

*Uses of the Machine.* From this description it can be readily seen that the designer of the BaCo Skylark has carried out in a practical and thorough fashion a conception of a machine which should serve extremely useful purposes, namely that of any other machine on the market. A very low power is employed with correspondingly low gasoline consumption, yet with modern methods of aerodynamics and structural design a better performance and more reserve power is provided than in many two-seater planes carrying a 100 hp engine. This side by side arrangement makes this machine ideal for instructional purposes or for taking up passengers on purely pleasure trips. At the same time the speed and endurance of the machine is such that it can be used for cross-country work and similar purposes. The sturdy construction also permits its use for stunt flying. The small over-all dimensions and simplicity of assembly and disassembly, the absence of a water system in the air cooled motor should enable the private user to maintain the machine with the least possible trouble and expense for storage, upkeep and repair, as well as for gasoline.

## Opening of Ae. C. A. Club House at Garden City

A formal opening of the Aero Club of America's new Club House at Hazelhurst Field, Garden City, L. I., will be held on Sunday, May 15 from 1 to 5 p.m.

A tentative program has been arranged which will include flying events of all descriptions:

1. The Army have agreed to furnish machines for various events. There will also be parachute drops, battle formations and demonstrations of bomb dropping upon the outlines of battleships marked on the ground, to show what the Army is planning to do in its coming demonstration upon real battleships off the Virginia Capes. They will also have the Ambulance "Eagle", to show how it is used to carry the wounded.
2. The Lawrence-Sperry Aircraft Corp will demonstrate a Sperry Messenger and give an exhibition of stunt flying with Avros. It is also expected that there will be some of the Army Orenco machines which will give an exhibition of aerial acrobatics.
3. There will be Air Mail machines flying and for exhibition on the lines and machines of the S.V.A. and Farman companies will also be represented.
4. The Curtiss Co. will have machines for exhibition and passenger carrying.
5. Miss Laura Bromwell will attempt to break her loop record and challenge Miss Jane Herveaux to an aerobatic contest.

Invitations have been extended to officers of the Air Service in Washington to fly up for this occasion.

The Club House of the Aero Club of America has been fitted up in a very attractive manner and it is expected to have many interesting functions and events upon this field during the coming season, including the Inter-collegiate races and Saturday and Sunday matinee races. An opportunity will also be offered to members of the Club to take flights and to arrange for flights for their friends.

## Western Airline Co.

The engineering division of the Western Airline Co has been located at Seymour, Ind. This division is incorporated under the laws of Indiana with a capital of $100,000 of which $54,000 00 had been subscribed on April 22. The entire issue will be sold.

Officers are C. E. Lay, president; J. A. Andrews, vice-president; L. P. Witherup, chief engineer, Myron S. Lay, construction engineer, E. L. Franz, treasurer and L. C. Hodapp, secretary.

Mr. Lay made the selection of Seymour for his plant last October and the work of promotion has been carried to success in the face of most severe financial conditions. It is expected Mr. Lay will have another important announcement to make about July 15. The company now controls several undeveloped Aviation fields.

# "Who's Who in American Aeronautics"



*Every week, AVIATION AND AIRCRAFT JOURNAL prints the biographical sketch of men who are prominent in American Aeronautics. These sketches will be published later in pamphlet form. As so many of the officers change their stations often, it is believed that a semi-annual issue will be necessary. In compilations of this character many errors and omissions occur. It will be appreciated if corrections are sent to "Who's Who" Editor.*

### John Francis Curry

CURRY, JOHN FRANCIS, Major Air Service born, New York City, April 22, 1886 son of J Frank Curry M D and Mary (MacKinnin) Curry married, Eleanor Dorothy Montgomery, Jan 4 1921

*Educated* Public schools of New York City, 1 year St Jerome's Academy, 5 years, 1909, U S Military Academy

*Aeronautical Activities* Detailed Aviation Section Signal Corps, Aug 1913, Pilot, 1st Aero Squadron, Pershing Expedition into Mexico, May 1916 to Jan 1917, commanding 6th Aero Squadron, Pearl Harbor, H T., Feb to July 1917, Office, Chief Signal Officer, Washington, D C, Sept to Nov 1917; Commanding Officer, Ellington Field, Tex., Nov 1917 to April 1918, Chief of Staff Air Service, 2nd Army, A E F, Oct 1918 to April 1919 Department Air Officer, Hawaiian Department Jan 1920 to date

*Flying Rating:* Expert Aviator, Aero Club of America 1916 Junior Military Aviator, Military Aviator Airplane Pilot.

*War Service* In regular Army during entire war in U S commanding flying schools, and in office, Chief of Air Service, to A E F at flying schools and Chief of Staff, Air Service, 2nd Army

*Member* Army and Navy Club (Wash.), Catholic Club (N Y)

*Present Occupation:* Department Air Officer, Hawaiian Department.

*Address* Headquarters Hawaiian Department, Honolulu H T

### Charles McHenry Pond

POND, CHARLES McHENRY, Engineer born, Berkeley Calif, Dec 18, 1882, son of Rear Admiral Chas Fremont Pond and Emma (McHenry) Pond married, Inez Virginia Henderson, Oct 15, 1919

*Educated* Public schools Berkeley, Calif and New York City Oahu College, Honolulu, T H., 1905 University of California

*Professional:* Engineering and exploration, railroad location, irrigation, and reclamation, from 1905 to 1914

*Aeronautical Activities* Learned to fly with Glenn H Curtiss at San Diego during the years 1914-1915 draughtsman at Curtiss Aeroplane Co at Buffalo N Y from Sept 1915 to Jan 1916, engaged in experimental work with Curtiss Aeroplane Co at Newport News from Jan 1918 to May 1918 draughtsman for Grinnell Aeroplane Co Grinnell, Iowa, May to Aug 1918

*Flying Rating* Aviator's Certificate No 397, F A I Aero Club of America.

*War Service* Instructor in flying, U S Air Service Oct 1918 to Jan 1919 (civilian instructor)

*Member* Pacific Aero Club Arctic Brotherhood, Sitka Alaska

*Present Occupation* Aviator and engineer

*Address* 4 East North St., Stockton, Calif home, 2811 Ridge Road, Berkeley, Calif

### Alfred A. Cunningham

CUNNINGHAM, ALFRED A Major, Marine Corps born Atlanta Ga, March 8, 1882 son of John D Cunningham and Cornelia (Dubose) Cunningham

*Educated* Gordon College

*Professional* Entered U S. Marine Corps, Jan 9 1909 as 2nd Lieutenant, continued as officer to date

*Aeronautical Activities* First Marine Corps officer ordered to aviation duty began this duty, Jan 1912 Senior Marine Corps Aviator since that date and in charge of Marine Corps aviation until Dec 1920 commanded 1st Marine Aviation Force of 4 squadrons over front in France

*Flying Rating* A C of A Hydroplane Certificate No 2 Navy Air Pilot No 5 Naval Aviator No

*War Service* In France Dec 15, 1917 to April 1, 1918, commanded 1st Marine Aviation Force of 4 squadrons at French front, Aug 1, 1918 to Dec 19 1918

*War Honors* Awarded Navy Cross

*Present Occupation* Commanding 1st Air Squadron U S M C

*Address* San Domingo City, D R., home, 1757 Massachusetts Ave., Washington, D C

### Lester Durand Gardner

GARDNER, LESTER DURAND, Publisher, born New York, August 7, 1876, son of Harry Gardner and Frances (Scott) Gardner married, Margaret Kettle of New York, 1913

*Educated* Detroit public schools, B S Massachusetts Institute of Technology 1898, Columbia University, 1900

*Professional* On Staff of Chicago *Journal*, New York *Sun*, New York *Mail*, *Everybody's Magazine* and *Collier's Weekly*, 1898-1911 Director, The Mentor Association, 1911-15, President, The Gardner, Moffat Co., Inc 1919 to date, publisher and editor of *Aviation and Aircraft Journal*, *The Rubber Age* and *Tire Trade Journal*.

*Aeronautical Activities* Publisher and Editor, Aviation and Aircraft Journal

*Flying Rating* On "flying status" and taking flying training when discharged from army

*War Service* In 1915 private, First Training Regiment, Plattsburg, N Y., Commissioned first lieutenant, Signal Officers Reserve Corps, August 1917 Captain Regular Army Aviation Section, Signal Corps and on active duty, September, 1917 Served for one year organizing Air Service squadrons at Kelly Field, Texas, 1918, commanding officer Aviation Camp, Waco, Tex., Major, Air Service (Aeronautics) September 17, 1918, on duty Board of Control, Department of Military Aeronautics when discharged, December 13, 1918

*Member* Society of Automotive Engineers, Aero Club of America, University Club (New York), University Club (Washington), Army and Navy Club (Washington), Technology Club Columbia University Club

*Address* 225 Fourth Ave home, 100 Morningside Drive, New York.

### Otto Earl Benell

BENELL, OTTO EARL, Chemist born Pueblo, Colo., June 17, 1898 son of Walter Scott Benell and Mary Eve (Bartels) Benell married, Ina Jeanette Foard, Aug 15 1920

*Educated* Public and high schools of Ft. Collins, Colo Dec 20, 1920 B S. Colorado Agricultural College

*Professional* 1919-1920, Chemist for Great Western Sugar Co. Ft. Collins, Colo., 1920-1921, Chemist for Great Western Sugar Co., Greely, Colo.

*Aeronautical Activities* Nov 1917 to Feb. 1918, student observer at Post Field, Ft Sill, Okla Tours, France, at 2nd A I C April 1918 Cazaux, France, Gunnery School, May 1918, French Escadrille Br 9 on Champagne Front, June July 1918, 135th Aero Squadron, Toul Sector Battle St Mihiel, Aug., Sept., Oct., Nov., 1918

*War Service* Army Air Service, May 14, 1918 to Jan 29 1919

*Honors* Sept 12 1918, at Thiacourt, France, decorated with Distinguished Service Cross

*Present Occupation* Chemist

*Address* Ft Collins, Colo

### John Belmont Jaynes

JAYNES, JOHN BELMONT, Automobile business born, Detroit, Mich. March 20, 1897 son of Thomas A Y Jaynes and Mary Jo Jaynes married, Lucile Bransford June 29 1918

*Educated* Grammar school and high school, business college

*Professional* Automobile business until entering army

*Aeronautical Activities:* Attended S M A Austin Tex and took primary training at Ellington Field, receiving commission as 2nd Lieut., May 21, 1918 transferred to Camp Dick Dallas Tex C C Squadron B Flying Officer's Wing ordered to Langley Field Hampton Va completed course at Langley Field, completed course at Taliaferro Field gunnery instructor considerable flying in commercial planes since discharged

*Flying Rating* Reserve Military Aviator, May 21, 1918

*Member* Aero Club of America

*Present Occupation* Automobile business.

*Address* 600 Commerce St., home, 403 W 10th St. Fort Worth, Tex.

### Ralph Royce

ROYCE, RALPH, Major Air Service born, Marquette Mich., June 28, 1890 son of George A. Royce and Kate (Ely) Royce

*Educated* 1908, graduated Hancock Central High School Hancock, Mich., 1914, U S. Military Academy

*Professional* Soldier, 2nd Lieut., 20th Infantry, June 12 1914 to Sept. 23 1915

*Aeronautical Activities:* Student, Signal Corps Aviation School, Sept. 1915 to March 1916 San Diego, Calif; Pilot, 1st Aero Squadron in Mexico and at border base, March 1916 to April 1917 Squadron Engineer Officer, Supply Officer, Adjutant and finally Commanding Officer on duty at Pilots School, Memphis and Chicago, two months overseas 22 months

*Flying Rating* Aero Club of America Pilot Certificate Dec 1915 Junior Military Aviator March 15 1918, Military Aviator March 19 1919, Airplane Pilot, June 9, 1920

*War Service* C O 1st Aero Squadron to June 1918 also C O 1st Corps Observation Group, from organization to that date Corps Air Service Officer to July 4th (1st Corps) Assistant in various Army Staff Air Service positions till Sept. 1st Air Service Representative 5th Sect General Staff A E F next ten months Assistant Dept Air Service Officer Southern Dept the next year C O Carlstrom Field since Aug 3

*Present Occupation* C O Carlstrom Field

*Address* Arcadia, Fla

### Chas. Stuart Macdonald

MACDONALD, CHAS. STUART, Airplane Manufacturer born Chicago, Ill Jan 11, 1889 son of Chas Alexander Macdonald and Martha S Macdonald

*Educated* University School Chicago

*Professional* Automobile business 1906 to 1911, from factory to agent automobile cost accounting 1911 to 1914 specializing in truck and garage operations

*Aeronautical Activities* Built copy Curtiss F boat, winter 1914 flew it at Lake Michigan summer 1915 joined sales department, Curtiss Co., Jan 1916, took active charge American Trans oceanic Co, N Y, June 1916 to Oct 1917 Ass't Mgr and Secretary, Interallied Aircraft Corp. N Y May 1919 to Jan 1921 Sales Mgr., Lawrence Sperry Aircraft Co, Jan 1921 to date

*Flying Rating* Seaplane pilot since 1919; land pilot since 1918

*War Service* 1st Lieut., U S Air Service, Nov 20, 1917 to Jan 19, 1919, stationed Selfridge Field Mt Clemens, Mich

*Member* Aero Club of America

*Present Occupation* Sales Manager, The Lawrence Sperry Aircraft Co, Inc

*Address* Farmingdale, Long Island, N Y, home, Shoreward Drive, Great Neck, Long Island, N Y

### Frederick Bedell

BEDELL, FREDERICK Professor born, Brooklyn N Y April 12, 1868 son of Edwin F Bedell and Caroline (Cunningham) Bedell, married Mary Louise Crehore July 1 1896

*Educated* Public schools of Montclair N J, A B 1890, Yale College for Undergraduates, Ph D 1892 Cornell University

*Professional* 1892-1899 Instructor at Cornell University 1899 to date Professor of Applied Electricity Cornell University

*Aeronautical Activities* Served on commission in 1917 for establishing U S Schools of Military Aeronautics

*Books* "Airplane Characteristics" 1919 "The Air Propeller" 1919 "The Airplane", 1920

*Member* Aero Club of America Pioneer Member Aeronautical Society of America Hon Member Aero Club of Ithaca Hon Member Cornell Flying Club Member and past Vice President American Institute of Electrical Engineers Fellow American Physical Society

*Present Occupation* Professor, Cornell University

*Address* Cornell University, Ithaca, N Y

# Plywood in Airplane Construction

By Armin Elmendorf, M. Sc., M. E.

*Consulting Engineer, Haskelite Manufacturing Corp., Chicago*

The material now called plywood by airplane engineers is also frequently referred to by many persons as veneer. The two terms, plywood and veneer, however, refer to two distinct materials. Among technical men, the term veneer is limited to designate the thin sheets of wood out of which plywood is made.

By gluing together sheets of veneer so that the fibers of one layer or ply cross those of the adjacent layers, the strength and other properties across the grain of the latter are greatly increased. This product is plywood.

### Plywood Does Not Shrink

If, in a 3-ply construction, the fibers cross at right angles, any stresses in the face veneers that may be caused due to a change of moisture content are balanced, and if the panel is otherwise properly made, it should remain flat. Due to the fact that the shrinkage of wood parallel to the grain is practically zero, and wood is stiff in the direction of the fibers, the shrinkage in the direction of the face grain or the core grain of plywood is negligible. A reduction in moisture content that would cause an ordinary board to shrink one-quarter inch across the grain may not cause a greater shrinkage than about .01 in. in plywood. It is this property that has made plywood such a valuable material for furniture. Airplane designers have also long recognized this as one of the striking characteristics of plywood. They know that even though airplanes are to be exposed to brilliant sunshine and then to rain, the panels that may be used on the sides or elsewhere retain their dimensions.

### Strength Properties of Plywood

While the strength properties of wood are fixed and cannot be changed except by lowering or raising the moisture content, the strength properties of plywood may be proportioned to suit requirements. By proper selection of veneer thicknesses in 3-ply panels, it is very easy to obtain a plywood in which the bending strength in the direction of the grain of the faces is equal to the bending strength across the grain of the faces. By a slightly different combination of thicknesses the tensile strengths in these two directions may be made equal. With still a third combination of thicknesses, the stiffness or modulus of elasticity parallel to the grain of the faces may be made equal to that across the grain.

It was not until the entrance of the United States into the war that an extensive schedule of strength tests on plywood was ever drawn up. At that time the Forest Products Laboratory at Madison, Wis., was called upon by the Navy, as well as the Army, to investigate the strength and other physical properties of this material. Strength tests were simultaneously conducted by private research laboratories such as that maintained by the Haskelite Manufacturing Corp. The latter company also made valuable investigations on methods of moulding plywood. The various tables of strength values and curves given in the following pages are based primarily upon the results of the tests made at the Forest Products Laboratory and are given in large part just as compiled by that institution.

### Tensile Strength

The stresses which may cause failure in the plywood of an airplane are of various kinds. A panel may be subjected to pulling or tensile stresses, or it may be bent or compressed. Of these the tensile stresses are most readily understood and are frequently referred to when the strength of plywood is spoken of. In actual service it will be found, however, that tension failures in airplane plywood are exceedingly rare. In case of a forced landing for example, a panel may be jerked from its moorings, or it may crumple or distort or buckle, but an actual rupture due to tension seldom occurs.

While rupture in tension is rare, the tensile strength of plywood frequently measures other strength properties and is useful in this way. The species listed in Table 1 include practically all commercial veneer species. In the last column of this table will be found the tensile strength of veneer of each species.

The tensile strength of any combination of species or thicknesses of veneer, as well as number of plies, may be computed by means of the strength figures given in column 11. The strength of wood across the grain being very small may usually be neglected. It may, for example, be desired to determine the tensile strength of a piece of 3-ply plywood parallel to the grain of the faces when the face veneer is birch and the core veneer yellow poplar. The strength contribution across the grain will be omitted. The tensile strength of a 3-ply panel parallel to the grain of the faces, assuming a face veneer thickness of 1/16 in., will be $2 \times 1/16 \times 19,815 = 2,470$ lb. per inch of width. If the yellow poplar core is 3/16 in. thick, then the tensile strength across the grain of the faces is $3/16 \times 11,080 = 2,080$ lb. per inch of width. The tensile strength of any other 3-ply panel or panels consisting of any number of plies may be computed in a similar manner.

TABLE I STRENGTH OF WOOD, PLYWOOD AND VENEER

| SPECIES | WOOD* Specific gravity oven dry based on volume when air dry | Per cent Moisture content at test | Bending strength lb. per sq. in. | Modulus of elasticity 1000 lb. per sq. in. | PLYWOOD** Average specific gravity based on oven dry wt. & vol. at test | Bending Strength: Per cent Moisture content at test | Bending Strength: Lb. per sq. in. par. to face grain | Bending Strength: Lb. per sq. in. perp. to face grain | Modulus of Elasticity: 1000 lb. per sq. in. par. to grain | Modulus of Elasticity: 1000 lb. per sq. in. perp. to grain | VENEER*** Tensile Strength Lb. per sq. in. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| Ash, Black | .50 | 10.4 | 13,600 | 1,990 | .48 | 8.1 | 7,760 | 1,770 | 1,070 | 98 | 6,270 |
| Ash, Commercial White | .56 | 8.7 | 16,600 | 1,688 | .60 | 10.2 | 9,932 | 2,620 | 2,420 | 149 | 9,765 |
| Basswood | .38 | 8.4 | 10,200 | 1,580 | .42 | 9.2 | 7,120 | 1,670 | 1,210 | 85 | 10,320 |
| Beech | .66 | 11.2 | 18,000 | 1,500 | .67 | 8.6 | 16,060 | 2,050 | 2,150 | 107 | 18,500 |
| Birch, Yellow | .63 | 9.8 | 18,900 | 2,708 | .67 | 8.5 | 16,000 | 4,200 | 2,260 | 107 | 19,815 |
| Cedar, Spanish | .37 | 7.3 | 8,100 | 1,076 | .41 | 10.3 | 8,400 | 1,480 | 1,080 | 84 | 7,830 |
| Cherry, Black | .51 | 8.2 | 16,300 | 1,540 | .56 | 9.1 | 12,280 | 2,020 | 1,990 | 132 | 12,080 |
| Chestnut | .44 | 8.8 | 9,700 | 1,330 | .43 | 11.7 | 5,160 | 1,110 | 740 | 75 | 5,665 |
| Cottonwood | .46 | 4.7 | 11,400 | 1,640 | .40 | 8.8 | 8,460 | 1,670 | 1,440 | 100 | 10,020 |
| Cypress, Bald | .44 | 5.5 | 11,800 | 1,540 | .45 | 8.0 | 8,890 | 1,850 | 1,220 | 85 | 6,240 |
| Douglas Fir (Coast Type) | .44 | 8.4 | 10,800 | 1,460 | .48 | 9.6 | 9,340 | 1,060 | 1,350 | 126 | 8,290 |
| Elm, Cork | .63 | 8.5 | 16,500 | 1,610 | .62 | 9.4 | 12,710 | 2,500 | 1,030 | 106 | 12,460 |
| Elm, White | .51 | 6.8 | 14,600 | 1,460 | .52 | 9.2 | 8,880 | 1,670 | 1,220 | 100 | 6,765 |
| Fir, True (White) | .36 | 7.2 | 9,800 | 1,400 | .40 | 8.5 | 9,200 | 1,211 | 1,560 | 100 | 8,800 |
| Gum, Black | .52 | 8.7 | 10,900 | 1,270 | .54 | 10.5 | 8,099 | 1,025 | 1,280 | 112 | 10,443 |
| Gum, Cotton | .52 | 8.1 | 11,800 | 1,620 | .53 | 10.3 | 7,760 | 1,580 | 1,300 | 111 | 6,990 |
| Gum, Red | .46 | 11.3 | 12,300 | 1,360 | .54 | 8.7 | 9,070 | 2,070 | 1,560 | 120 | 11,775 |
| Hackberry | .54 | 9.2 | 12,800 | 1,250 | .54 | 10.2 | 8,100 | 1,880 | 1,150 | 96 | 10,675 |
| Hemlock, Western | .42 | 8.8 | 10,808 | 1,322 | .47 | 8.7 | 9,250 | 1,960 | 1,580 | 112 | 10,290 |
| Magnolia | .51 | 6.8 | 12,500 | 1,488 | .58 | 8.8 | 10,880 | 2,600 | 1,700 | 106 | 13,820 |
| Mahogany, African | .50 | 4.5 | 15,400 | 1,620 | .52 | 12.7 | 8,070 | 2,000 | 1,260 | 144 | 8,055 |
| Mahogany, True | .52 | 4.8 | 12,100 | 1,430 | .48 | 11.4 | 8,500 | 1,840 | 1,250 | 117 | 9,880 |
| Maple, Soft | .48 | 8.2 | 10,100 | 1,210 | .57 | 9.8 | 11,540 | 2,420 | 1,750 | 165 | 12,275 |
| Maple, Hard | .52 | 10.5 | 15,800 | 1,620 | .68 | 6.0 | 14,000 | 3,140 | 2,110 | 168 | 15,285 |
| Oak, Commercial Red | .63 | 10.6 | 14,200 | 1,870 | .59 | 9.5 | 9,500 | 2,070 | 1,290 | 120 | 8,220 |
| Oak, Commercial White | .68 | 11.8 | 15,200 | 1,780 | .64 | 9.5 | 10,600 | 2,610 | 1,340 | 116 | 10,100 |
| Pine, Sugar | .37 | 11.4 | 8,600 | 1,210 | .42 | 9.4 | 8,050 | 1,070 | 1,310 | 90 | 8,100 |
| Pine, White | .38 | 6.0 | 9,600 | 1,420 | .42 | 6.8 | 10,180 | 2,050 | 1,870 | 111 | 5,590 |
| Poplar, Yellow | .41 | 8.1 | 11,800 | 1,610 | .50 | 9.4 | 6,880 | 1,620 | 1,540 | 115 | 11,080 |
| Redwood | .42 | 11.0 | 11,000 | 1,070 | .42 | 9.7 | 8,230 | 1,550 | 1,180 | 108 | 7,150 |
| Spruce, Sitka | .38 | 8.6 | 11,200 | 1,610 | .42 | 8.3 | 7,710 | 1,000 | 1,370 | 105 | 8,450 |
| Sycamore | .50 | 6.2 | 11,200 | 1,310 | .55 | 9.2 | 11,040 | 2,240 | 1,130 | 140 | 12,040 |
| Walnut, Black | .57 | 4.2 | 17,000 | 1,620 | .56 | 8.1 | 12,660 | 2,770 | 1,740 | 142 | 12,575 |
| Yucca Species | | | | | .40 | 7.6 | 2,660 | 900 | 560 | 44 | 3,310 |

* Bulletin No. 556 U. S. Department of Agriculture
** Tests made on 3-ply panels in which all plies in any one panel were of same thickness and species, grain of successive plies at right angles. In most cases thickness ranged from 6/30 in. to 3/8 in.
*** Single ply parallel to the grain (not plywood). Moisture same as in Column 5



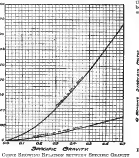



Fig. 1. Curve Showing Relation between Specific Gravity and Bending Strength of 3-Ply Plywood in Lb. Per Sq. Ft.

### Bending Strength

While any failure of plywood in aircraft is very rare, it must nevertheless, be guarded against. Actual failures in service or under tests are due more often to bending than to any other cause. The bending strengths listed in Table 1 under columns 7 and 8, may be used for purposes of computing or comparing bending strengths. By substituting these strength values in the common flexure formula used in bending strength computations, the thickness of a plywood member may be determined if the external forces acting on such a member are known. The strength values as given apply, however, only to plywood made of three laminations, in which each lamination or ply of a given panel is of the same thickness and species.

In using the strength table, the differences in moisture content must be considered. The strength of wood increases rapidly with reduction in moisture.

By comparing the strength values in columns 7 and 8, as well as the curves in Fig. 1, it will be seen that for the plywood in which all plies are of the same species and thickness, the bending strength parallel to the face grain is about 4½ times as great as the bending strength across the face grain.

When all plies of a 3-ply panel are of the same thickness, the ratio of the core to the total thickness is 0.33. In order to obtain a bending strength for any other combination of thicknesses, the curves given in Fig. 2 may be used. If, for example, the core is twice as thick as the faces, that is, the ratio of the core to the total thickness is 0.5, then the bending strength parallel to the face grain is 0.84, as great as if all plies were of the same thickness. For this same ratio

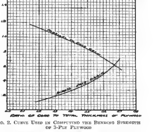



Fig. 2. Curve Used in Computing the Bending Strength of 3-Ply Plywood

of core to the total thickness, the bending strength across the face grain is 0.36 times the bending strength parallel to the face grain of a panel in which all plies are of the same thickness. For this ratio of thicknesses the strength parallel to the face grain is to the strength across the face grain as 0.84 is to 0.36. It will be seen, therefore, that even though the thicknesses of the plies of a 3-ply panel are so proportioned as to get the same *tensile* strength in the two directions, the *bending* strength parallel to the face grain is about 2.5 times as great as across the face grain. It will be seen further, from Fig. 2, that if the core is about two-thirds of the total panel thickness, the bending strength parallel to the face grain is equal to that at right angles to this direction.

When the bending strength values given in Table I are plotted against the corresponding specific gravities for each of the species, two curves such as those shown in Fig. 1 are obtained. The points do not all fall on these two curves; they are, in fact, rather widely scattered, but the general law holds, namely, that the strength of plywood increased with its weight or specific gravity. Birch, for example, is heavier than yellow poplar, and also stronger. In the same way yellow poplar is heavier than Spanish cedar and stronger than the species. While the curves shown in Fig. 1 were obtained for the various species given in Table 1, similar curves are obtained by plotting the strength values for a given species. If, for example, a large number of tests are made on yellow birch specimens, it will be found that the weight of the specimens tested varies somewhat and that there is a corresponding variation in the strength. It is generally true that the heavier a piece of wood of a given species, the stronger it is. In using the strength figures given in Table I, this variation of individual strength values must be kept in mind.

### Species to Use for Airplane Plywood

To date the selection of species used for airplane plywood, one would think, has sometimes been made upon the basis of cost of the species, assuming that the value of the wood was in proportion to its cost, or possibly the selection was made on the basis of the strength only with no consideration of the weight. Mahogany, for example, has apparently been used very frequently for no other reason than that it is a "high grade wood", meaning that it is attractive and expensive. It so happens that mahogany also has very desirable mechanical properties so that by selecting this species no mistake was made. There are, however, other species equally good which might have been used, and used at a considerable reduction in cost. Birch has likewise been used because it is a very strong wood. The fact that it is also heavy has been overlooked.

In selecting a species for airplane plywood, it is important therefore, first to know how its strength per unit of weight compares with that of other commercial species.

Tests made on airplane monocoque fuselages and certain types of wing ribs have shown that when these members are made of plywood and tested to destruction, initial failure is

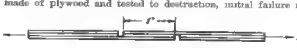



Fig 3 Test Specimen for Determining Strength of Glue Joint

usually caused by buckling or local column failure It is imperative, therefore, to select a species which will give the greatest resistance to buckling per unit of weight. Buckling is first an elastic phenomena and the resistance to buckling is measured by the modulus of elasticity It will be seen from Table I that the modulus of elasticity of the heavy or high density wood is greater than that of the low density wood The stiffness or resistance to buckling of a panel also depends upon its thickness From the usual beam formulas or Euler long column formula, it will be remembered that stiffness is proportional to the cube of the thickness Assuming the same weight, it will be seen therefore that the stiffness is proportional to the reciprocal of the cube of the density

Comparisons of stiffness or resistance to buckling were made in the author's paper on Aviation for Sept. 15, 1920, "The Design of Monocoque Fuselages". The relative resistances to buckling of such low density woods as redwood, spruce, yellow poplar and Spanish cedar, were compared with such species as birch, beech and sugar maple, and it was found that the low density woods were between 2 and 2½ times as resistant to buckling per unit of weight as the high density woods. The conclusion is drawn, therefore, that for airplane purposes in which failure due to buckling is liable to take place (and that means practically all airplane plywood), it is preferable to use low density woods rather than the heavier or high density woods, even though the latter are stronger for the same thickness. Yellow poplar and spruce are probably the leading low density veneer woods of commercial importance.

### 3-Ply Versus 5-Ply

The airplane designer is often confronted with the selection of the number of plies to use for a certain panel Frequently a decision is made on the contention that the 5-ply is "better" than the 3-ply, or stronger If the gluing of a 3-ply panel is not thorough, or the quality of the glue is not of the best, then separation of the plies is more liable to occur for the 3-ply than for the 5-ply panel because the plies of the 5-ply panel are thinner and the stresses therefore smaller If, however, a 3-ply panel can pass a thorough boiling or soaking tests, then there is no reason why it should not be used just as well, or even in preference to the more costly 5-ply construction

The government requires that plywood which is to be used in airplane construction must withstand a boiling test of eight hours or a soaking test of ten days without separation of the plies

Panels that are thicker than ⅜ in. are, however, preferably made of more than three plies for manufacturing reasons For very thick panels ⅛ in. plies for all except the face plies give satisfactory results and are practical from the point of view of manufacture. The face veneer should in general be thinner than ⅛ in.

### Tests to Determine Quality of Gluing

Any panel that will withstand the government test previously mentioned should be entirely satisfactory for service in so far as the quality of gluing is concerned If a panel can withstand eight hours of boiling or ten days of soaking in water, it should not fail in service A strength test may, however, also be resorted to. A strip of plywood one-inch wide may be notched as shown in Fig 3, and pulled in tension. If such a specimen will sustain a load of about 200 lb before failure takes place, the quality of gluing is good Or, if failure is due to rupture of the wood and not due to shearing of the glue joints, even though failure occurs at a load less than 200 lb, the quality of the gluing may be relied upon

*(To be continued)*

## A Portable Electric Drill

There has been received from the Van Dorn Electrical Tool Co, of Cleveland, Ohio, a note on the application and maintenance of the Portable Electric Drill by E. L. Connell, chief engineer of this company

The portable electric drill is essentially an electric motor and should be given all the protection and consideration usually required for such apparatus. The small sizes in common use are equipped with a universal motor and drive the chuck through a train of gears which reduce the speed from 5 to 25 times The power is supplied through a flexible cable with lamp socket connection and is controlled by a switch conveniently located on the handle of the drill. A typical drill weighs 10½ lb, and is capable of drilling 5/16 in. holes as fast as the operator can force it through the work.

The capacity of a drill varies with the material, and the speed for maximum production changes with condition The makers of the drills are prepared to recommend drills for special application such as wood boring, where the capacity of the tool may vary widely from its rated capacity in steel.

The speed appearing on the name plate is the free running speed and bears no definite ratio to the speed under load. The speed will drop 25 to 50 per cent or more under load. This automatically adjusts the speed of the machine to correspond with the size of drill being used and the hardness of the material. An operator who has become acquainted with the tool will have no use for a two speed mechanism with gear shifting mechanism The greater simplicity and ruggedness of the single speed tool would even justify some compromise if a compromise were necessary

The minimum drilling performance of Universal portable electric drills are given in the following table

Carbon Steel Drills in .20 to .30 Carbon Steel

| Capacity of tool and size drill | Speed | Rate of feed inches per minute | Horsepower at 1 hp per cu in metal removed per minute |
|---|---|---|---|
| ¼" | 800 | 1½ | .08 |
| 5/16" | 650 | 1⅜" | .10 |
| ⅜" | 525 | 1¼ | 13 |
| ½" | 375 | 1 | 19 |
| ⅝" | 300 | ¾ | 23 |

The free running speed will be about twice the speed given in the above table, except where the tool is designed for a lower cutting speed. The capacity of the motor should appear on the name plate in amperes and the motor should be capable of carrying this load for 30 min. without over-heating

All reputable tools of this type have enough power to prevent stalling except under accidental circumstances When this does happen, the power should be cut off as soon as possible, although momentary stalling will not injure a well designed machine

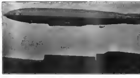
Other interesting details are given in this note, which is obtainable from the manufacturers.

# The British Passenger Airship G-FAAF

By Ralph H. Upson

The airship works of William Beardmore, at Inchinnan, Glasgow, Scotland, have recently completed the first British commercial airship The vessel was laid down during the war as the R 36 for the Royal Air Force, but was redesigned after the Armistice with a view to serve commercial purposes The civil identity mark of the ship is G-FAAF

The G-FAAF belongs to the improved R-34 class of airships. She is 672 ft. long, that is, 30 ft. longer than the famous ship which crossed the Atlantic in the summer of 1919 both ways. The maximum diameter is 78 ft. 9 in. and the capacity 2,100,000 cu. ft, which gives the ship a nominal lift of 63 5 tons The power plant consists of three 350 hp Sunbeam "Cossack" and two 260 hp. Maybach engines which are mounted in separate power cars. The control car is, unlike on the R-34, where it was suspended from the hull like the power cars, built adherent with the under side of the hull and communicates directly with the passenger quarters The latter afford sleeping and dining accommodations for fifty



The British Passenger Airship G-FAAF over the Shed at Inchinnan, Scotland

passengers. The crew consists of four officers and twenty-four men The maximum designed speed of the G FAAF is 65 m p h, and her range at cruising speed is 4,000 miles.

The G-FAAF is, as has been said above, a development of the R 34, which in its turn was modeled after the German L-33 class. The new ship therefore differs but little in its general lines from Zeppelin practice, although many details have been worked out in a totally different manner The framing in most of the structure of the new ship is identical with that of the R-34, except for the addition of a gas cell in the center section, whereby the overall length is increased to 672 ft Thus, although the internal structure is rather conservative, the final arrangements and details nevertheless include many features that are extremely interesting

One important change from the R-34 is found in the arrangement and the composition of the power plant. The same number of engines is used, but each of the five is installed in a separate power car instead of two being coupled in an after power car, like on the R-34. As a result there are five separate power cars, four of which are wing cars, while the after car is in the center line The forward wing cars each contain a British built Wolseley-Maybach 260 hp engine, direct connected to its propeller. The other three engine cars each contain a Sunbeam "Cossack" engine, developing 350 hp., which drive the respective propellers through a reduction gearing It is stated on good authority that the new arrangement of the power plant is greatly superior to that of the R-34, for it not only saves a considerable amount of weight, but also furnishes a higher speed despite the larger volume of the G-FAAF The later is slightly faster than the R-34 although its disposable lift was originally some 9,500 lb greater, but this difference has since been made up by fitting the passenger car.

The control system of the R-36 also shows a certain improvement over that of its prototype, having slightly larger fins and a better thought out method of operation The nose construction provides for mooring to a mast and permits to replenish the airship with fuel, water and gas through suitable pipe connections. There is also provision for taking on and putting off passengers through the nose and the mast, but this part of the problem has not yet been completely worked out Nevertheless, the whole arrangement of the nose, with all the increased convenience it offers, represents a notable step in the right direction

Special precautions have been taken to guard against fire; for example, all the vents from the fuel tanks are lead outside the ship

An interesting development which has apparently not been tried before for rigid airships, is the landing frames, which

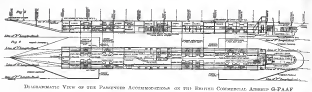
Passenger Accommodations on the British Commercial Airship G-FAAF

are designed to fit one under each end of the ship These are only attached after landing to assist in running the ship in and out of the shed. This landing frame idea has evidently originated through such trouble as was experienced with the R-34 in this country, when one of the cars was somewhat damaged due to its being dragged heavily over the ground.

The passenger accommodations are extremely interesting and are of course the most novel part of the design These are much more elaborate than have ever been fitted before, in fact it is the first case in record where sleeping berths have been fitted as regular equipment

From the standpoint of location, the car has reverted to the central type used in Germany before the war in contradistinction to the "Bodensee" arrangement, which has the car well forward It has been stated that the object of putting the car in the center is to permit the passengers to walk about without disturbing the equilibrium of the ship. This is false reasoning, however, as for a given length of car its position makes absolutely no difference in this respect. The central position does offer the advantage of permitting a more flexible choice between passengers, baggage, fuel, air, etc. The disadvantages are that it brings the pilot's bridge further back and makes it practically necessary to put engines to the front and sides of the car, where their noise, vibration and wind is a little more evident than with the "Bodensee" arrangement.

As may be seen from the accompanying diagram, reproduced from *Engineering*, the independent cabins are arranged something on the order of a Pullman car, with curtains between, except that the beds are laid crosswise instead of longitudinally The object of this is to make less noticeable the slight pitching movement, which is the only noticeable motion to be felt in an airship of this size The beds can be folded up



Diagrammatic View of the Passenger Accommodations on the British Commercial Airship G-FAAF

ont of the way in the day-time, a folding table and two wicker chairs taking the place of each pair of berths. The large windows at each side permit looking out and slightly downward. There are twenty-five double cabins beside lounging space, kitchens, lavatories, etc. The ship is electrically lighted throughout and also provided with wireless telephone and telegraph. The latter includes direction finding apparatus, which is an important contribution to the safety of navigation. The control cabin and pilot's bridge constitute the extreme front end of the passenger car. For the crew of four officers and twenty-four men accommodations are provided in the keel inside the hull.

What the new airship will be used for, has not yet been definitely decided. Although one of the largest yet built, it is much too small for even a pretense of commercial use across the Atlantic. To carry the full passenger list of 50, with a reasonable amount of baggage and mail, the distance between stops would have to be kept well under 1000 miles. It is stated that the route between London and Marseille (about 630 miles) can be covered in 15 to 18 hr. with an average of 30 passengers and 4,500 lb. of mail or express. This estimate seems amply conservative both as to time and load.

Present-day knowledge in airship construction would make possible a considerable improvement in design even for the same size, for it should be realized that this ship, although very well built, is practically a 1915 design and 1919 construction. Its load carrying and propulsive efficiency are considerably improved by the later examples of rigid and semi-rigid construction. The faults of the R-36 as a passenger ship, however, appear on the safe side, for they are largely the result of various parts being over-substantial rather than the reverse. Just the same, the future history of the G-FAAF should be watched with great interest, because if successful it will be convincing proof that an improved design can be still more successful, from a financial standpoint.

The airship was recently transferred by the Royal Air Force to the Department of Civil Aviation of the British Air Ministry and the latter intends to inaugurate with her an experimental passenger service from London to Egypt and India, which is to be operated by a chartered company. In this connection it is significant that the Royal Air Force has relinquished all its airships to the civil air authorities of Great Britain, the ground taken being the great expense incurred in operating and maintaining these vessels in time of peace. The civil air authorities now intend to convert the whole fleet into commercial vessels. The fleet comprises beside the G-FAAF the old wooden hulled Short ship R-32, the Armstrong-built R-33, the new Vickers R-80 and the surrendered Zeppelins L-71 and L-64. They are all of the rigid type and have, with the exception of the R-32, duralumin hulls.

## Ansaldo Cabin Plane Flies from New York to Chicago

The Ansaldo A-300C Shown Above on May 7-8 Flew from Mineola, Long Island to Chicago in 7½ Hr. Flying Time. It Was Piloted by Lloyd Bertaud and Carried Three Passengers and 500 Lb. of Express Matter for the American Railway Express Co.

# The Determination of Downwash

By Lt. Walter S. Diehl

*Bureau of Construction and Repair, U. S. N.*

It is obvious that, in accordance with Newton's second law, the lift on an aerofoil must be equal to the vertical momentum communicated per second to the air mass affected. Consequently a lifting aerofoil in flight is trailed by a wash which has a definite inclination corresponding to the factors producing the lift. It is thought that sufficient data, theoretical and experimental, are now available for a complete determination of this wash with respect to the variation of its angle of inclination to the originating aerofoil and with respect to the law which governs its decay in space.

### *Munk's Formula for Downwash*

Although it has long been known that the angle of downwash, $\varepsilon$, as observed at a given point behind the aerofoil, is

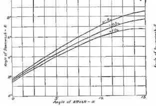



Fig. 1 Variation of Angle of Downwash with Depth Y Below Upper Wing

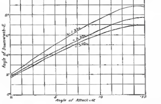



Fig. 2 Variation of Angle of Downwash with Distance Y Behind Wings

directly proportional to the lift of the aerofoil (Br. A.C.A. R. & M. No. 196) and inversely proportional to the aspect ratio (Lanchester "Aerial Flight" Vol. 1, Chapter VIII, Br. A.C.A. R. & M. No. 161), Munk (Technische Berichte III-1) seems to have been the first to propose a quantitative solution. He asserts that $\varepsilon$ must be represented as the product of some constant and the angle of attack as expressed by the formula (Betz, T.B. 1-4),

$$\alpha = \frac{57.3}{\pi} \cdot 2L_c \left(\frac{S}{b^2}\right)$$

where $b$ is the span, $L_c$ is the lift coefficient and $S$ is the area of the aerofoil. The formula for downwash then becomes

$$\varepsilon = c \cdot \alpha = \frac{57.3c}{\pi} \cdot 2L_c \left(\frac{S}{b^2}\right)$$

the value of the constant $c$ being determined by experiment. The formula as given applies to monoplanes, but may be applied to multiplanes, according to Munk, by the introduction of another constant $k$ which reduces the span $b$ to the span of the equivalent monoplane.

The values of $c$ were determined for several models by photographing a series of streamers. Owing to the lack of certain vital data, the results have not been included in this study, but the conclusions are given instead. It appears that the equation, as given above, is not general. The values of $c$ vary somewhat more than is allowable for a "constant". No attempt was made to determine the variation of $c$ with aspect to ratio, nor was any allowance made for the inevitable dying out or the wash effect in space. It appears, however, that the angle of downwash is substantially constant over about eight-tenths of the span, with sudden changes near the tips.

### *N. P. L. Formula*

The most comprehensive series of tests on downwash, which have been published, are those by Sandison, Glauert and Jones (Br. A.C.A. R. & M. No. 426). In this investigation the variation of downwash was determined in space for a number of points behind, above, and below the trailing edge of the aerofoil. It was found that, in accordance with hydronamic theory,* the angle of downwash decreases exponentially with the distance from the aerofoil (a biplane in this case) and might be expressed by the empirical formula

$$\varepsilon = \varepsilon_0 \, 10^{-\ldots \, \xi^{-\ldots} \, \theta}$$

where

$\xi$ is the distance behind the wing in chord lengths.
$\theta$ is the distance below the chord of the upper wing in terms of the gap,
and $\varepsilon_0$ is a constant for any given arrangement.

This appears to have been the first attempt to express the variation of $\varepsilon_0$ from point to point. With a satisfactory law for the variation of $\varepsilon_0$ it would have been complete.

### *Derivation of a Comprehensive Downwash Formula*

It is now possible to derive a comprehensive downwash formula based on the Göttingen theoretical and the N.P.L. empirical formulas. It is known definitely that downwash varies exponentially with distance from the trailing edge. The plotted results of N.P.L. investigations, which show this variation vertically and horizontally, are given in Figs. 1 and 2, respectively. The data in Fig. 1 have been replotted on a logarithmic scale in Fig. 3, with the vertical distance from the trailing edge expressed in chord lengths plus one chord length* as abscissa and angles of downwash as ordinates. It is found that for a given angle of attack, the angles of downwash at various vertical distances from the trailing edge lie on a straight line. The lines corresponding to the various

N. A. C. A. Technical Note No. 42

* See Lanchester, Aerial Flight, Vol. 1, Chap. III

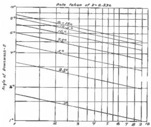



FIG 3 VARIATION OF ANGLE OF DOWNWASH WITH DEPTH BELOW WING

angles of attack are all parallel and have a slope of -13° ± 0.5° This indicates that the variation of angle of downwash with vertical distance from the trailing edge can be represented by an equation of the form

$$\epsilon = c_1 (y + 1)^*$$

where $c_1$ = a constant

$y$ = the vertical distance, of the point under consideration, in chord lengths, from the trailing edge.

and $n = \tan(-13° \pm 0.5°)$
$= -0.23 \pm 0.01.$

In a similar manner the data from Fig 2 have been plotted in Fig 4 The points again fall near parallel straight lines but their slope, -21° ± 0.5°, is steeper than that in Fig 3 The indicated variation of the angle of downwash with variation of horizontal distance from the trailing edge is of the form

$$\epsilon = c_2 \,.\, (x + 1)^*$$

where $c_2$ = a constant,

$x$ = the horizontal distance, of the point under consideration in chord lengths, from the trailing edge,

and $n = \tan(-21° \pm 0.5°)$
$= -0.38 \pm 0.01.$

* This is necessary so as to provide a finite value at the trailing edge

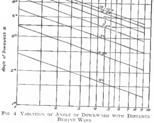



FIG 4 VARIATION OF ANGLE OF DOWNWASH WITH DISTANCE BEHIND WING

In order to eliminate the calculations involving fractional exponents the functions,

$$Z = (x + 1)^{-0.38}$$
$$Z = (y + 1)^{-0.23}$$

have been evaluated and plotted in Fig 5

Data from five series of downwash determinations have been plotted in Fig 6, with angles of downwash as ordinates and lift coefficients as abscissas The slope of the straight line, which passes through the points representing a series of tests, determines the value of $\Delta\epsilon/\Delta L_c$ for that particular arrangement and the point in space at which the observations were taken The aspect ratio, the value of $\Delta\epsilon/\Delta L_c$, and the coordinates of the observation point are given, for each series of tests, in Table I.

It is evident from inspection of Fig 6 that ε varies directly with lift coefficient. It has also been shown by data from the

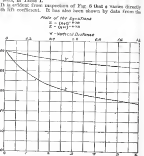



FIG. 5 DISTANCE FROM TRAILING EDGE IN CHORD LENGTHS

tests of Sandison, Glaubert, and Jones (Br. A.C.A. R. & M. No 426) how ε varies in space Munk's equation indicates that ε varies inversely as the aspect ratio n Therefore the angle of downwash should be given by

$$\epsilon = \frac{K}{n} \,.\, (x + 1)^{-0.38} \,.\, (y + 1)^{-0.23} \,.\, L_c$$

where $K$ is a constant, numerically equal to $\Delta\epsilon/\Delta L_c$ at the trailing edge of a wing of aspect ratio unity.

The value of $K$ is determined for each of the five series of tests which are plotted in Fig 6, by substituting the proper values for the functions of $x$ and $y$ and for the aspect ratio n. The procedure is indicated by the headings of columns in Table I

It is found that $K$ is substantially constant, varying from 164 to 176, a single exception of 158 corresponding to a series of tests on biplane arrangement, the wings of which were equipped with flaps and represent abnormal conditions It therefore appears that the angle of downwash can be represented to a good approximation by

$$\epsilon = \frac{170}{n} \,.\, (x + 1)^{-0.38} \,.\, (y + 1)^{-0.23} \,.\, L_c$$

$$\epsilon = \frac{170}{n} \,.\, F_x \,.\, F_y \,.\, L_c$$



$F_x$ and $F_y$ being the values of the functions of $x$ and $y$ which are given in Fig. 5

The validity of this formula is obviously confined to that range of angle of attack or lift coefficient in which the air flow about the aerofoil is not abnormally turbulent.

### *Application of the Downwash Formula*

The chief use of a downwash formula is the calculation of the aerodynamic angle of attack of the horizontal tail surfaces. For this purpose a reference point is taken on the leading edge of the horizontal tail surfaces and the values of ε obtained from the formula. The aerodynamic angle of attack of the tail surfaces will then be

$$\alpha_t = \alpha - \beta - \epsilon$$

where α is the angle of attack of the wing and β is the acute angle between the chord lines of the wings and horizontal

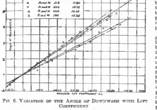



FIG 6 VARIATION OF THE ANGLE OF DOWNWASH WITH LIFT COEFFICIENT

tail surfaces, considered positive (in the equation) if the tail is set at a less apparent angle than the wings.

The data from tests seem to indicate that in case of a biplane the maximum angle of downwash occurs in the horizontal plane midway between the two wings. The effect is so slight, however, that the above method may be used, referring the coordinates of the reference point to the nearest wing (preferably to the no lift line), with the assurance that the results so obtained will be as precise as it is practicable to calculate them with the data now available.

TABLE I
DETERMINATION OF K IN THE EQUATION

$$\epsilon = \frac{K}{n} \,.\, F_x \,.\, F_y \,.\, L_c$$

| Source of Data | Aspect Ratio n | $\Delta\epsilon / \Delta L_c$ | x | y | $F_x$ | $F_y$ | $\frac{\Delta\epsilon}{\Delta L_c}\left(\frac{1}{F_x \cdot F_y}\right)$ | $K = \frac{\Delta\epsilon}{\Delta L_c}\left(\frac{1}{F_x \cdot F_y}\right) n$ |
|---|---|---|---|---|---|---|---|---|
| N C-1 Curtiss Tests | 9.5 | 11.20 | 2.5 | 0 | .626 | 1.00 | 17.9 | 170 |
| R&M 180 | 6 | 15.20 | 2.6 | 0.55 | .64 | .96 | 26.4 | 166 |
| R&M 426 | [illegible] | 14.70 | 6.0 | 0.61 | .566 | .68 | 37.8 | 167 |
| R&M 426 | 6 | 16.00 | 6.0 | 0.43 | .596 | .916 | 29.6 | 176 |
| R&M 515 | 7.73 | 11.6 | 2.6 | 0.6 | .62 | .896 | 21.2 | 164 |

NOTE. There will be a slight decrease in the value of $\Delta\epsilon/\Delta L_c$ with increase in lift coefficient if the reference point is not fixed in space. This is caused by the change in the coordinates of the point with change in angle and the effect may easily be accounted for

Let $D$ = distance from trailing edge, $T$, to reference point $P$.

$\theta$ = Inclination to horizontal of line $TP$

then $x = D \,.\, \cos\theta$
$y = D \,.\, \sin\theta$

## Aeronautical Sessions, A.S.M.E. and S.A.E.

A joint aeronautical meeting will be held by the American Society of Mechanical Engineers and the Society of Automotive Engineers at McCook Field, Dayton, Ohio, on May 21

The committee in charge of the joint meeting includes Major G E A Hallett, Glenn L Martin and Joseph A. Steinmetz, with Maj. Thurman H. Bane as Chairman. The plans of the committee indicate a varied program for the day, with the morning devoted to an inspection tour of the shops at McCook Field in active production. Flights will probably be made in the early afternoon, and the technical session in the late afternoon will close the day. Major Bane's talk on the Future of the Air Service at this session will be accompanied by more of the motion pictures that have proved of so much interest at previous aeronautic sessions in which he took part

At the summer meeting of the Society of Automotive Engineers, which will be held at West Baden, Ind., from May 24 to 28, next, aeronautics from the economic standpoint will be the keynote of the Aeronautical Sessions. Aeronautics from the viewpoint of design has heretofore held our attention almost exclusively, but the time has come when we are becoming aware that, despite past labors on construction and design, air transportation is as yet a thing remote. The reasons for this slow development of commercial aviation have been chosen by V. E Clark, of the Dayton-Wright Co., as the subject for his paper at this Session. He will indicate why a very rapid development of air transportation cannot be expected at the present time and in this way endeavor to bring both the too optimistic and the too pessimistic to a broader viewpoint of the problem. An interesting comparison of transport by airplane, by airship, by train, by automobile and by water—from the aspects of speed, cost and safety—will be included in the paper

With Federal control the one need of commercial aviation today, a discussion of the economic phase of aeronautics would necessarily include this subject. Financiers are not willing to risk the establishment of an air line when there is no Government legislation to give the undertaking a real status The course that this legislation would have to take in order to encourage the industry and prevent much sectional legislation will be outlined by S. H. Philbin, of the law firm of Fish, Richardson & Neave, in his paper, "The Need of Federal Control in Commercial Aviation"

The subject of airplane engine installation and means of improving the reliability of the entire power plant is to be considered in a paper on the "Power Plant of Today and Its Development," by G J. Mead, Chief Engineer of the Wright Aeronautical Corp., which was written in collaboration with L. E. Pierce, Plane Engineer of the same company.

## Caldwell Brothers to Resume in 1922

Caldwell Brothers, who formerly maintained an aircraft exhibition and tours service at Galesburg, Ill., and whose planes were destroyed in a fire last year, have abandoned their plans for continuing their business this season. New planes, which the company proposed to purchase could not be delivered until after the exhibition season had closed and it was accordingly decided to wait until 1922 before resuming their business.

## Marine Corps Air Mail in Haiti

The United States Marine Corps has established airplane mail delivery on the islands of Haiti and Dominican Republic, according to an announcement made by the Navy Department. In addition to this the flyers are making a photographic map of the entire coast line of Haiti.

# French State Aerodromes for Civil Use

French commercial aviation disposes of three distinct kinds of aerodromes, namely — (1) Public aerodromes maintained by the government for commercial uses, (2) Military aerodromes temporarily opened for commercial uses, and (3) Private aerodromes. The following information which is taken from *L'Aéronautique* (Paris), deals only with the first named, or state aerodromes.

The French state aerodromes are created and operated by the Air Navigation Service of the Sub-Secretariate of Aviation and Air Transport. They may be used by civil aircraft upon payment of certain landing and sheltering fees. These aerodromes are located along certain approved air routes and are divided according to their importance into airports (*aéroports*), air stations (*aérogares*), landing stations (*stations aériennes*), rest stations (*haltes aériennes*) and emergency fields (*terrains de secours*).

The creation of these aerodromes is directed by the following principles. As soon as a certain amount of air traffic

Map of France Showing Air Routes in Operation or under Construction at the End of 1920

is foreseen between two important cities, the Air Navigation Service starts the establishment of an air station on the outskirts of each city. If the growing importance of the air traffic warrants it, this air station is eventually developed into an air port

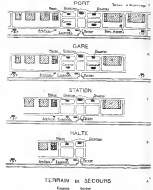
Along the air route connecting the two cities emergency fields are provided at intervals of about 30 miles, which distance may be increased or decreased in accordance with the prevailing atmospheric conditions and the nature of the ground. Where the country is flat and lends itself to emergency landings, the distance between the fields may be greater, while on routes where fogs are frequent a greater number of emergency fields is required.

If the air route exceeds a certain length and comprises junction points with other air lines, these places are equipped with rest stations or landing stations in proportion to their importance

The approximate location of the aerodrome being determined, the Air Navigation Service proceeds to acquire the site required. This is often a difficult undertaking, because in France real estate is generally cut up into small holdings and the desirable site of a single aerodrome may be owned by as many as thirty proprietors If but one of these refuses to sell his property, the state has to expropriate him, which procedure may take one or two years.

The site being acquired, the work of equipping the proposed aerodrome may begin Where no drainage is required the various operations of levelling and rolling take about a month, whereupon clover is sown to make the ground resilient

As a rule, the Air Navigation Service chooses the sites for its proposed aerodromes in such a way that any emergency field can, should the necessity arise, be converted into the most complete ground establishment, that is, an airport. To effect such a conversion all that is needed is to provide the equipment




*Développement des aerodromes d'État pour l'aviation civile*
$T_1$ $H_1$ Ateliers et magasins, $H_2$ Hangar pour avions de passages, $S_1$, $S_2$, $T_2$ Hangars-abris pour avions

Type of Civil Aerodromes Organized by the French Government

necessary, for the site itself must be capable of the expansion required.

The accompanying diagram illustrates this scheme. The emergency field shown in *A* does not comprise any hangar, its equipment consisting only of a gasoline pit (*essence*) and of a small house for the watchman (*gardien*), who is provided with a few first aid tools. Eventually an aerological station, indicated (*A*), can be added to this equipment. The field faces, as every other class of aerodrome, a highway or road.

Under *B* there is shown a rest station. This is fitted with a standard hangar, 112 ft. by 100 ft. (S), a workshop, an aerological station (*meteo*), a radio station (*T S F*) and a fireworks pit (*artifices*), beside the necessary administration building (*direction*) and the gasoline pit.





The landing station shown in *C* differs from the rest station in that there is an additional standard hangar of small size and one of large size, the latter being 165 ft by 120 ft. A customs house (*douanes*) is also provided for.

The evolution of the landing station into an air station, *D*, and into an airport, *E*, can easily be followed on the diagram. All the installations shown are open to transient aviators and aerial travellers. In addition to this equipment, the government may construct hangars which it rents to air navigation concerns at a fixed rental. These hangars, with some minor shop equipment and offices, are situated at the right and the left of the standard equipment

## Book Reviews

Flying Guide and Log Book 1921 Edition By Brace Eytinge, Hon. Lieut., R.A F, Pilot (John Wiley & Sons, Inc, New York. 174 pp, 38 ill )

The Flying Guide and Log Book, which has just come off the presses, is the second enlarged and revised edition of the Landing Field Guide and Pilot's Log Book which Lieutenant Eytinge compiled in 1920 Like its predecessor, the 1921 issue of this excellent book lists all the federal, municipal, commercial and private air ports, seaplane stations and emergency landing fields throughout the United States. The entire reading matter has been brought up to-date and a whole lot of valuable detail information (size of field, distance and relative position to nearest town, facilities, etc.) has been added, which still further enhances the value of this well known guide

Photographs of the principal permanent air ports, taken from aircraft, are included for the first time in this issue and form an interesting feature, making recognition from the air an easy matter.

Flying rules enforced on all government flying fields—which should likewise be observed on all civilian fields—and the Army Air Service specification for municipal air ports are printed in full and materially add to the value of the book. In addition many helpful hints for those engaged in aviation are given, such as trouble shooting in airplane engines, requirements for pilots of flying machines provided for in the International Air Navigation Convention, etc

The help the Flying Guide and Log Book affords to any pilot planning a cross country trip is obvious at first sight. Being of handy pocket size, bound in limp leather and printed in easily legible type, it cannot but help becoming the inseparable companion of every flying man. Outside the flying world, municipalities and chambers of commerce will probably derive much valuable information on matters aeronautical, particularly if their particular city or town lacks a flying field and thus does not appear as a desirable stopping point for aircraft.

The Aeroplane Handbook Edited by A. J. Swinton (The Aeroplane & General Publishing Company, Ltd, London, 276 pages, tables and diagrams)

This is a collection of short monograms by well known writers on aeronautics, most of them reprints from the British and American technical press. Only a few of the monograms are original

Aeronautical instruments are dealt with by Capt A F C Pollard This chapter gives the fundamental principles of such instruments as altimeters, compasses, aero and distance calculators, speed indicators, and similar instruments

Strength calculations, by John Case, gives a concise statement of a somewhat complicated method of stress analysis. This section in the handbook may prove useful to designers already familiar with the subject A section on mathematics contains a useful summary of information which should be always at hand. The only information on materials is a short article by Joseph Wilson on high tensile steel wires.

There are short and excellent statements on spray paint, varnishing and doping, by C. L. Burdick, on dope by A. J. A. Wallace Barr, and on glue, by Dr George F Lull Each of these individual contributions is concise and well written, but there is no information given on the properties of steel, veneer, or any other materials employed in aircraft construction, with the exception of a few tables.

A note on stability by Captain W. Gordon Aston is interesting reading, but open to criticism in many parts Performance of the airplane, by John Case, is well handled but gives too little data. Propellers, by E P. King, is well illustrated by diagrams and drafts. Wireless telegraphy as applied to aircraft by R. Bangay makes excellent reading for aircraft people who have no great knowledge of the subject of wireless. There are also articles on aircraft testing, spinning, patents and patent law

The book is well bound and well printed, but is could hardly be called a comprehensive handbook. It is rather a collection of good articles and notes on certain branches of aeronautics, covering the field only to a certain extent, interesting in themselves, but certainly not serving the function of a handbook as commonly understood

Aerial Year Book and Who's Who in the Air, 1920 (Cross-Atlantic Newspaper Service, Ltd )

Aviation has now reached the point where there is sufficient going on in its various branches for some one to collect the outstanding points of interest in one volume The Aerial Year Book and Who's Who in the Air, 1920, not only contains the events of the year 1919 but has in addition authoritative statements of what has happened in the past and what may be expected to develop in the future.

The introduction is by Lord Northcliffe who says in part "This issue of the first of the 'Aerial Year Book' is a milestone on the road towards successful commercial aviation." There are six parts to the book which contain the following topics Part I, the general aspects, Part II, the R. A F, Part III, civil aviation, Part IV, technical, Part V, aviation in the United States, Part VI, Who's Who in the Air

Each of the features is covered by a leader in that field. Such men as C G Grey, G Holt Thomas, Glenn H Curtiss, Brig-Gen. E. H. Maitland, T O M. Sopwith, W. Gordon Aston, etc, lend dignity and authority to any book. One of the features of the book is the very complete publication of the International Air Navigation Convention and the English Air Navigation Acts and Regulations. The world's aviation records as homologated by the F A I. are given in detail but unfortunately only extend to June 30, 1914. The Who's Who section contains upward of one hundred and forty names.

## Entries for National Balloon Race

The Aero Club of America has received the following entries for the National Balloon Race to be held in Birmingham, Alabama, in May 21:

Roy F. Donaldson will pilot the balloon "City of Birmingham" and will have W. E. Robinson of the University of Illinois as his aide.

Wade T Van Orman will pilot the balloon "City of Akron" and will have Willard P Seiberling as his aide. This is sponsored by the Akron Chamber of Commerce.

J S McKibben, of 3645 Laclede Avenue, St Louis, Missouri, will pilot the balloon "St. Louis No. 5".

H. E Honeywell, Price Road, Clayton, Missouri.

Ralph Upson, 22 East 17th Street, New York with C. G Andrus, U. S Weather Bureau, as his aide

It seems assured that there will be three entries from the Army and one from the Navy.

The Aero Club has taken up matters with the Air Board, Ottawa, Canada, to see what rules and regulations may be required of pilots who cross the border into Canada so that they may return and bring their balloons back in safety It may be that some bond may be required to insure performance.

## Home Insurance in Southern California

The Home Insurance Company of New York has appointed A J Ralph, 904 Hibernian Building, Los Angeles, Calif, as its Southern California representative for placing aircraft insurance Mr Ralph's activities will cover the counties of Santa Barbara, Ventura, Los Angeles, Orange, San Diego Imperial, San Bernardino and Riverside

## University of Detroit to Have Aero Course

Thomas F. Dunn, recently appointed Dean of Aeronautics of the University of Detroit, was in Washington recently to enlist the aid and support of the Army Air Service in the inauguration of the University's new course in aeronautical engineering for which an entire building has been arranged for.

It is proposed to divide the course into three main parts. The first is a complete ground course similar to that given in the various Air Service schools of military aeronautics during the war at various colleges throughout the United States. The second part is a continuation of the first, enlarged upon and incorporated with its laboratory work. The remainder of the course continuing in aeronautical studies includes the usual course of mechanical engineering. Upon the completion of these courses, or coincident with the latter part of the work, actual flying instruction may be taken by the students. The work of flying is optional and given only at the discretion of the University officials. The aeronautical course leads to a degree of Bachelor of Science, Mechanical Engineering or Aeronautical Engineering. Mr. Dunn stated that the studies pursued would be such that it might be possible for a student to qualify so as to receive his degree in mechanical engineering even though his work did not permit him to receive the aeronautical degree.

The course as outlined and contemplated by the university is to serve two purposes. First, the preliminary course is so arranged that it may be taken as a complete short course in aeronautics for those who either have personal reasons or business desires to become acquainted with the subject, but who do not wish to go into the study as deeply as those who intend to do actual designing or engineering work. The course as a whole is intended to be such as will give to the degree when granted, the same dignity and meaning as that which is carried with the various engineering degrees of the recognized universities. The length of the course will be five years on the cooperative basis, that is, for each week of study there will be a week of practical work in the various manufacturing plants engaged in the building of aeronautical equipment. The first class is to start in June.

The aeronautical building is of concrete, four stories, 100 x 200 ft. The University has a flying field comprising 114 acres and its location on the banks of the Detroit River will permit flying instruction to be given during the course, both with land water craft. Mr. Dunn, who is to be the head of this department, is an ex-Air Service officer, with practical experience in the operation of commercial aircraft engaged in transportation work.

A list of colleges giving courses in aeronautics was published in the March 7 issue of Aviation and Aircraft Journal.

## McCook Field Builds 1,000 Hp. Engine

The Engineering Division, McCook Field, has completed preliminary design of a 1,000 hp 18-cylinder engine. This preliminary work indicates that such an engine can be constructed on conservative lines and may be expected to give an excellent power to weight ratio, at the same time maintaining a very conservative loading of all vital parts, thus insuring great dependability and long life.

The design is being further developed on the basis of 1,000 hp. at 1400 r.p.m. direct drive, this speed insuring great reliability and being favorable to high propeller efficiency in connection with a large power output.

A cylinder of the proposed design has been constructed and tested with very satisfactory results. This cylinder has a bore of 6½ in. with a 7½ in. stroke. It is of the 4-valve type with welded steel jackets. Dynamometer tests of the single cylinder indicate that the 18-cylinder unit may reasonably be expected to develop 1,000 hp. at 1,400 r.p.m., with a very satisfactory fuel consumption. The cylinders are arranged to accommodate four spark plugs per cylinder, which has some advantage from the point of view of power output and economy. Furthermore, it is planned to use four independent magnetos, thus securing the utmost reliability through the use of four entirely independent ignition systems.

## INDEX TO ADVERTISERS

# THE AIRCRAFT SERVICE DIRECTORY

*Where to Procure Equipment and Services*

AIRPLANES — ENGINES — PARTS — ACCESSORIES — TRAINING FOR PILOT OR MECHANIC — EXHIBITION WORK — AERIAL ADVERTISING — PASSENGER CARRYING — PARCEL CARRYING — AERIAL PHOTOGRAPHY AND MAPPING

## AVIATION - MOTOR

30-40 H.P 2 cyl opposed, air cooled, weight 128 lbs., Ideal motor for light aeroplanes

**Price only $200 complete**

NEW, READY TO RUN

108 Trolleyway, **BORDELON** Venice, Cal

## REDUCTIONS

IN NEW CANUCK & OX 5 ENGINE SPARE PARTS

New Rome Turney Rads, $25—C.A.L. & Paragon Props $20 etc

Also a complete assortment of

3½ per cent. nickel steel bolts, screws, clevis pins, eyebolts, nuts, ferrules, thimbles, turnbuckles, wire and cable

*Write for our 1921 price list*

**AIRCRAFT MATERIALS AND EQUIPMENT CORP.**

1407-9 SEDGWICK AVE. NEW YORK CITY

## Air Speed Indicator

WRITE FOR INFORMATION

**PIONEER INSTRUMENT COMPANY**
**136 Havemeyer Street Brooklyn N Y**

## G&O Radiators

Government inspectors found fewer leaks in G & O airplane radiators than in any other type tested during the war.

THE G & O MANUFACTURING CO.

NEW HAVEN CONN.

*WRITE FOR OUR SPECIAL PRICE LIST*

**CANUCK, JN., AVRO AND OX-5 PARTS**

Canuck

**ERICSON AIRCRAFT LIMITED**

120 KING ST., EAST, TORONTO, CANADA

**WANTED – Parachute jumper and equipment**

Attractive proposition for July and August

*Apply, giving records, terms, etc.*

Box 1201, Saskatoon, Sask. Canada.

## AERO CAMERAS

U. S. SIGNAL CORPS SURPLUS

For mapping and oblique work, can also be used as hand camera, box all metal, finished in olive drab focal plane shutter, automatically set when changing plates. 4 x 5 size. Lens equipment 8½" F 4.5 Tessar 18 septum plate magazine and carrying chest. A $250.00 VALUE AT $140.00

Wire your order

BASS CAMERA COMPANY

Aero Dept. 109 N Dearborn St., Chicago, Ill.

## Aerial Cameras and Accessories

***Aerial Photographs***

**FAIRCHILD AERIAL CAMERA CORP.**
**136-146 West 52nd St., New York.**

## HAMILTON PROPELLERS DELIVER THE GOODS

HAMILTON AERO MFG. CO.

678 LAYTON BLVD. MILWAUKEE, WIS.

## ACETATE AEROPLANE DOPE

We still have a limited quantity of COVERNMENT APPROVED acetate dope which we are offering at less than one half manufacturers price

**Bramer-Kelly Canfield Co.,**

134 Sixteenth Street, Buffalo, N. Y.

## PRICE REDUCTION

—on—

**New and Rebuilt JN4D, Canuck, F Boat, OX & K-6 Motors, Parts**

Immediate delivery

**CURTISS EASTERN AIRPLANE CORP.**

130 So Fifteenth St., Philadelphia, Pa.

## PHENIX FIREPROOF DOPE

on your plane will avoid the risk of FIRE spreading over the plane. PHENIX FIREPROOF PAINT on the wood work prevents the burning of the wood.

*Send for circular, samples and prices.*

Aluminum and Clear

**PHENIX AIRCRAFT PRODUCTS CO.,**

WILLIAMSVILLE N Y

*FLY OVER THE*

**LOS ANGELES—LAS VEGAS—SALT LAKE AIRWAT**

The best route to fly over. You can land at Lynndyl, Milford, Lund, Modena, Uvada, (Utah), Crestline, Barkley, Caliente, Carp Moapa, Dry Lake, Las Vegas, Roach, (Nevada), Kelso, Yermo, Victorville, San Bernardino, Pomona, Los Angeles, (California)

*For further information address*

LAS VEGAS AVIATION CLUB,
BOX 240, LAS VEGAS, NEVADA.

## L. P. WITHERUP

**Mechanical Designing Engineer**

D ESIGNS
D EVELOPMENT
D ETAILS
D ELIVERY

For any fuel from Crude Oil to Gasoline, any type, for any service, from farm to airplane engines.

Specialist on Two-Cycle

Submit Me Your Bearing Problems

Lock Box 1472, Cincinnati, O



THE EARLY BIRD (HD-1 B)

**OUR AIRPLANES ARE PRODUCED BY MEN EXPERIENCEO IN THE OESIGN ANO CONSTRUCTION OF COMMERCIAL ANO WAR TIME AIRCRAFT OF ALL TYPES**

| Type | Weight Full Load | Useful Load | Motors | Number of Motors and H P. | Lbs. per H.P | Lbs. per sq ft | Selling price without motor | Selling price with motor |
|---|---|---|---|---|---|---|---|---|
| HD-1B | 2858 | 5 seats 1100 lbs | 10 cyl Anzani | 2 100 200 | 14.1 | 8.5 | $4,500. | $5,700. |
| HD-4E | 1940 | 2 or 3 seats 740 lbs. | 10 cyl Anzani | 1 100 100 | 19 4 | 5.9 | $4,200. | $4,800. |

# HUFF, DALAND & CO., INC.

**OGDENSBURG, NEW YORK**

AIRPLANES — FLYING BOATS — MOTOR BOATS

A Section of the Metal Shop

# Wittemann Aircraft Corporation

**TETERBORO, HASBROUCK HEIGHTS, NEW JERSEY**


Only Lakeside Aviation Oil Could Do It
There is but one aviation lubricant in the World whose average consumption by the aeronautical motor is .0165 lbs. per H. P. per hour under any and all flying conditions. That lubricant is
Lakeside Aviation Oil
Scientifically refined from famous Franklin First Sand Crude
LAKESIDE AVIATION OIL is produced from the very finest crude oil in existence—Franklin First Sand Crude. This vital feature explains its almost unaccountable performance as compared with other ordinary aviation lubricating oils.
The great economy and efficiency of LAKESIDE AVIATION OIL has made it possible for pilots to venture into the vast deserts of Mexico and to the rim of the artic circle where oil storage must last as long as gas. LAKESIDE AVIATION OIL lasts *twice* as long as the gas supply of the Liberty motor.
Write for a copy of the "Textbook of Aeronautical Lubrication"—an authentic guide in the science of correct lubrication. There is no charge for this booklet.
We are the producers and distributors of LAKESIDE AVIATION OIL—scientifically refined from famous Franklin First Sand Crude.
Write for particulars and quotations.
THE C. L. MAGUIRE PETROLEUM COMPANY
First in Aviation Petroleum Products
McCORMICK BLDG. Chicago, Ill.
WHITEHALL BLDG. New York, N. Y.
LYNCH BLDG. Tulsa, Okla.
MUNSEY BLDG. Washington, D. C.
661 PELHAM ST. St. Paul, Minn.
Franklin, Pa.
Lakeside Aviation Oil